

Information Visualization In Practice

How the principles of information visualization can be used in research and commercial systems

James Tam

Putting Information Visualization Into Practice

A Common Problem

- There is a large set of information to represent.
- The display space is limited.
- Also:
 - Providing all the details all at once is not useful (results in overload).
 - Showing only a subset of the information may result in a lost of context.

James Tam

Too Much Information To Show All At Once



James Tam

Another Example Of The “Large Data Set – Limited Display Space Problem” : Adventure/RPG Games



Dungeon Master (Java version) <http://www.cs.pitt.edu/~alandale/dmjava/>

James Tam

Too Much Information To Show All At Once

Approaches to the problem:

- 1) Scrolling**
- 2) Overview and detail**
- 3) Magnification**
- 4) The DragMag**
- 5) Transparent overlays**
- 6) Zooming**
- 7) Focus and context**

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1) Scrolling



Scrolling along one dimension



Scrolling in two dimensions

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2) Overview And Detail: Separate



Overview



Detailed view

Images from "Information Visualization" by Robert Spence

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2) Overview And Detail: Separate



Defender © Midway Home Entertainment Ltd.

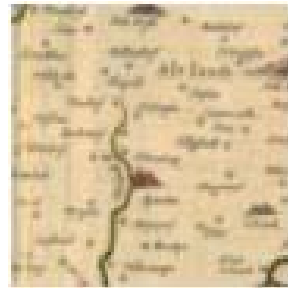
James Tam

2. Overview And Detail: Separate

Relating the detailed and overview can be a challenge:



Overview



Detailed view

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3) Magnification: Inline

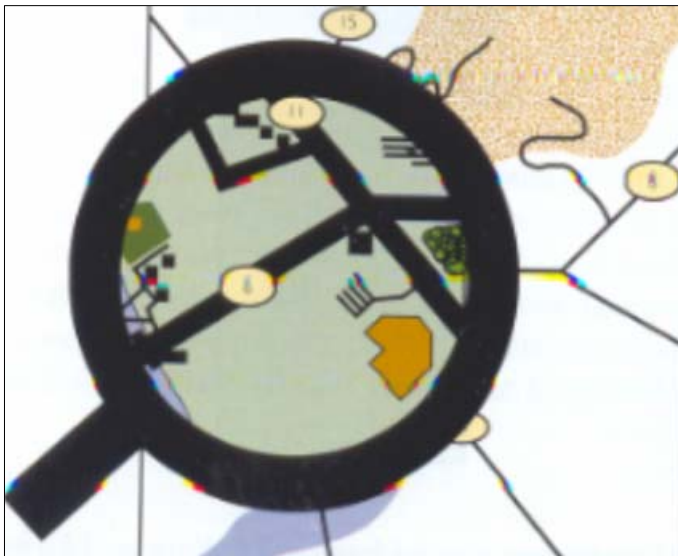


Image from "Information Visualization" by Robert Spence

James Tam

3) Magnification: Inline

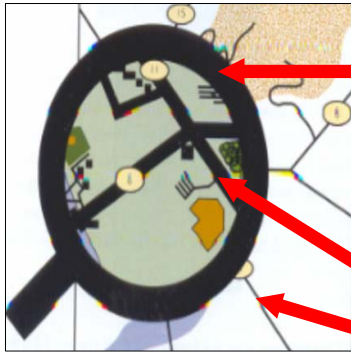


Image from "Information Visualization"
by Robert Spence

Problem 1:
Occlusion of the area
to be viewed by the
viewer

Problem 2:
Lack of continuity
between the
magnified area and
the surrounding
context.

James Tam

3) Magnification: Mutually Exclusive



Icewind Dale © Interplay productions

James Tam

3) Magnification: Mutually Exclusive



Icewind Dale © Interplay productions

James Tam

4) The DragMag



Image from "Information Visualization" by Robert Spence

James Tam

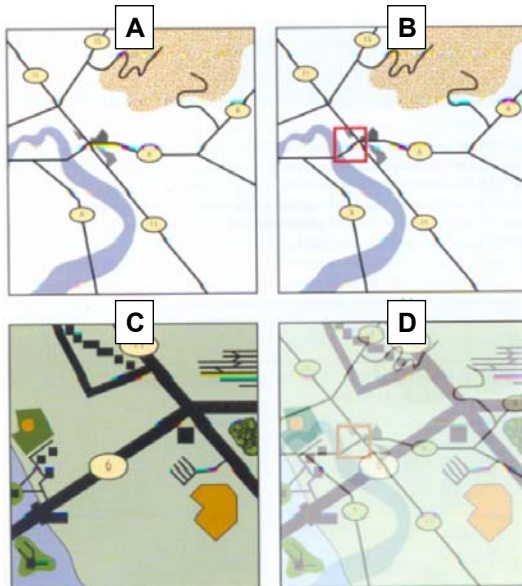
4) The DragMag



Image from "Information Visualization" by Robert Spence

James Tam

5) Transparent Overlays



Key:

- A. Overview
- B. Which part of the overview will be magnified
- C. The magnified portion of the overview
- D. The magnified view transparently overlaid on the overview

Image from "Information Visualization" by Robert Spence

James Tam

5) Transparent Overlays

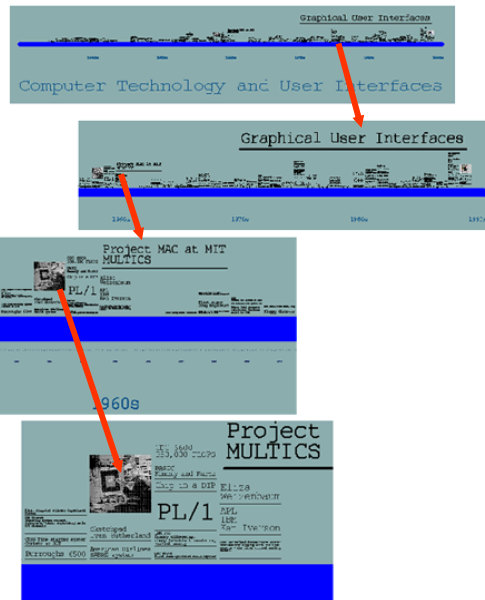


Diablo © Blizzard

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6) Zooming

Pad++: A Zoomable Graphical Sketchpad for Exploring Alternate Interface Physics
Bederson et al
Journal of Visual Languages and Computing 7, 1996



Browsing of digital images

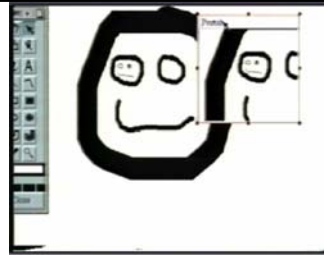
<http://java.sun.com/features/2001/08/photomesa.html>

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Pad++: The Details

Not a system in and of itself!

- A proposed alternative to WIMP interfaces.
- Allows for zooming to be added to existing systems (“ZUI’s”)



Characteristics

- An infinite 2D plane
- Objects can be placed anywhere
- The plane can be scaled to any size

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Zooming Need Not Be Just Tied To Simple Magnification/Reduction Of Size!

Some ways that zooming can show more (or less information)

A. Aggregation

B. Filtering

C. Semantic zooming

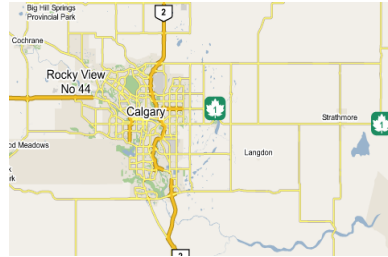
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A. Aggregation

Aggregation – combine information into some compact yet meaningful way



Zoomed out



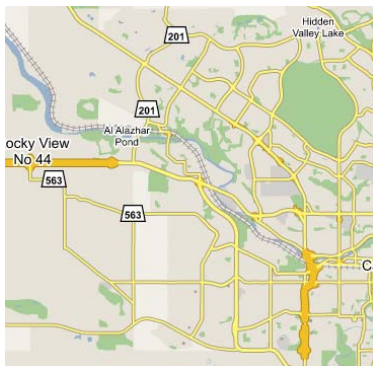
Zoomed in

Images from Google Maps: <http://maps.google.com/>

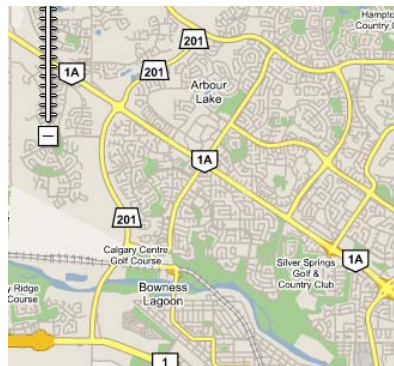
James Tam

B. Filtering

Block the appearance of some of the information



Zoomed out



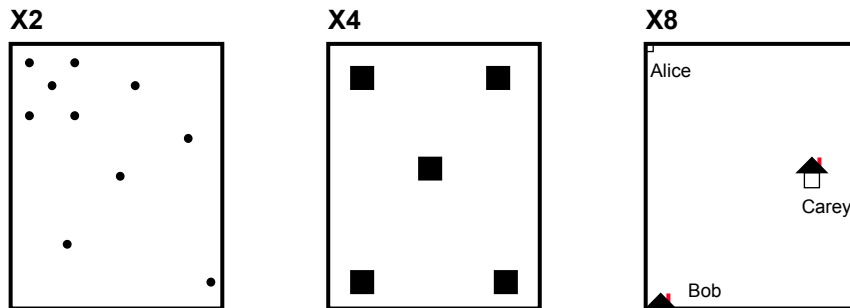
Zoomed in

Images from Google Maps: <http://maps.google.com/>

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C. Semantic Zooming

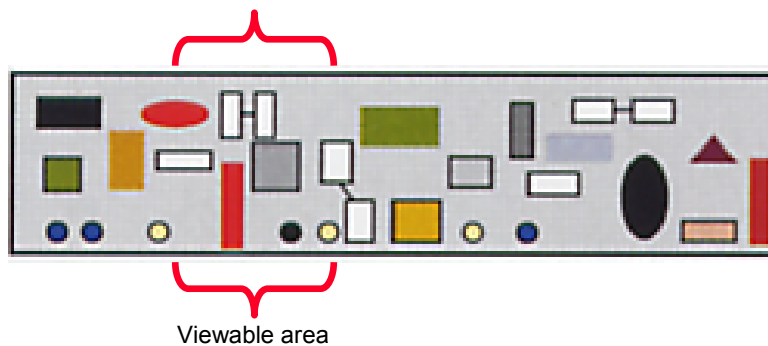
At different zoom levels the same information may appear in the display but it is represented in a different fashion:



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7. Focus And Context

- Again the amount of the information is too large to display all at once.

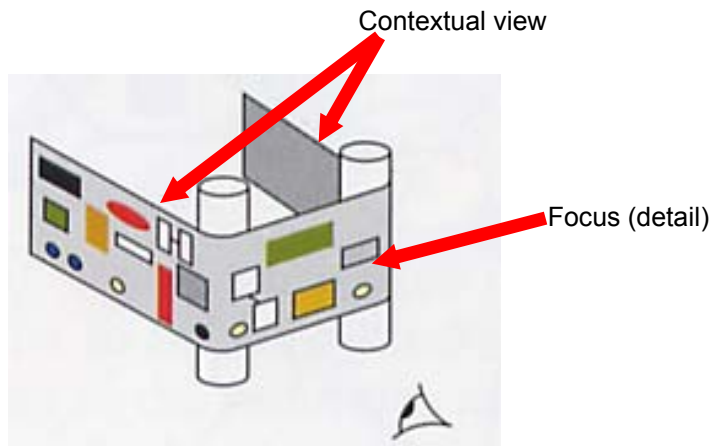


From "Information Visualization" by Robert Spence

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7) Focus And Context

- With this approach detailed view can still be viewed within its surrounding context.



From "Information Visualization" by Robert Spence

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The Fisheye Lens: Photography

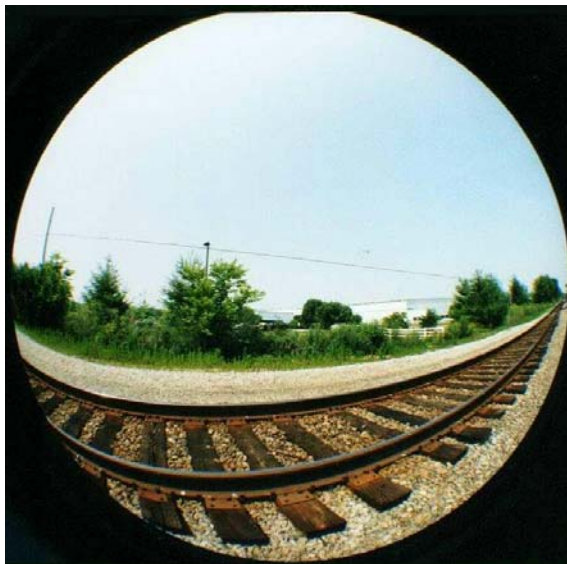
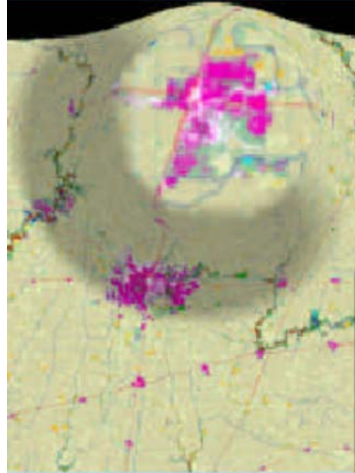
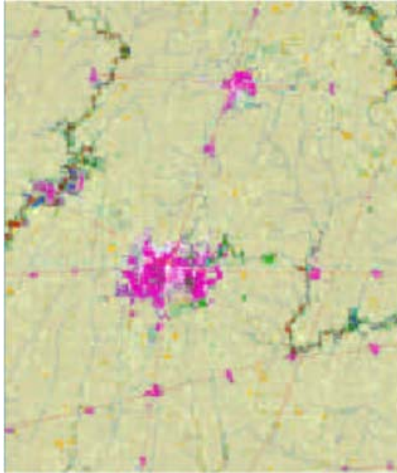


Image from: http://rick_oleson.tripod.com/

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Fisheye View: Information Visualization

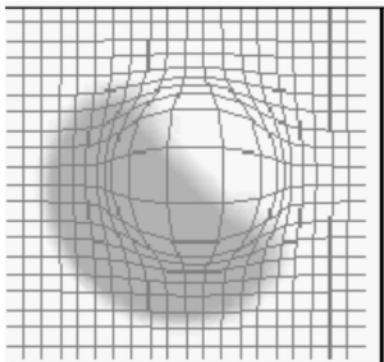
An application of the focus and context approach



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Fisheye View: Visual Cues For The Distortion

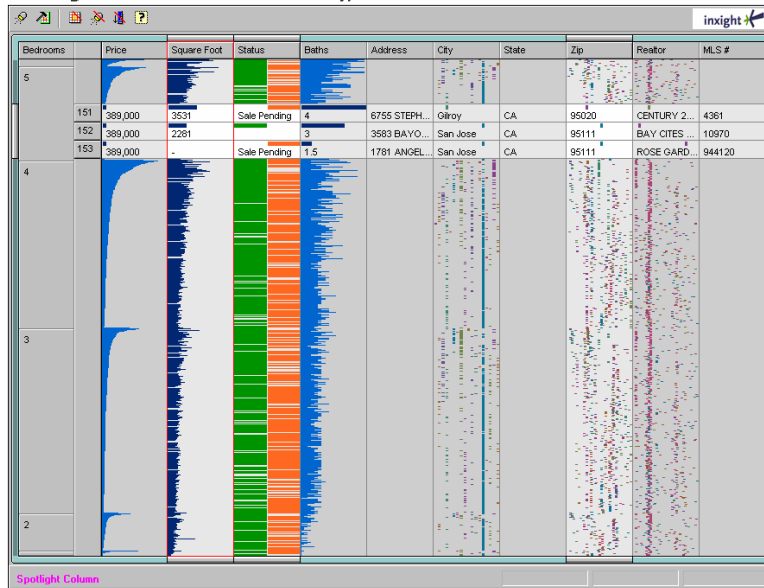
Distortion is understandable through the use of a grid and shading



James Tam

Table Lens

Housing Market for Santa Clara County, CA - March 2000



James Tam

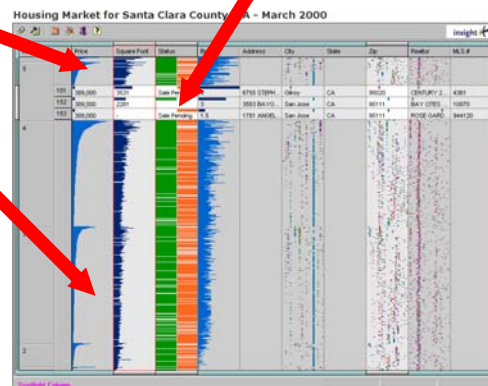
Table Lens

Overview:

- Show all the information in an abstracted graphical form

Focus:

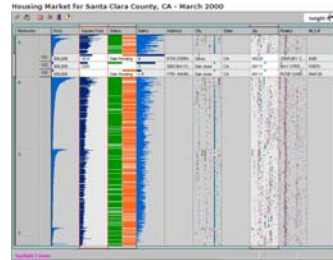
- Show all the details of only a subset of the data.



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Table Lens : The Details

- Abstracts a large volume of data into a small space.
- The overview may allow the user to spot:
 - Trends
 - Patterns
 - Outliers
- Details are provided on demand
- The data can be manipulated



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Focus And Context: Distortion In One Dimension

- Distortion in the X-dimension

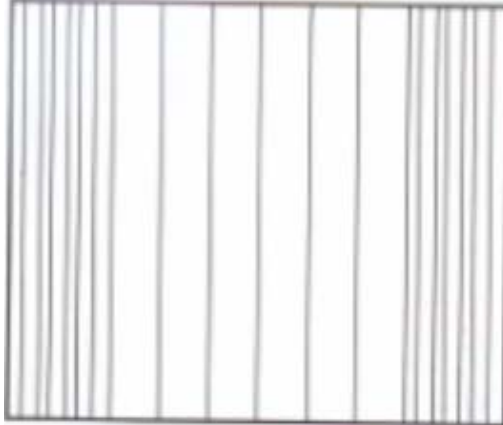
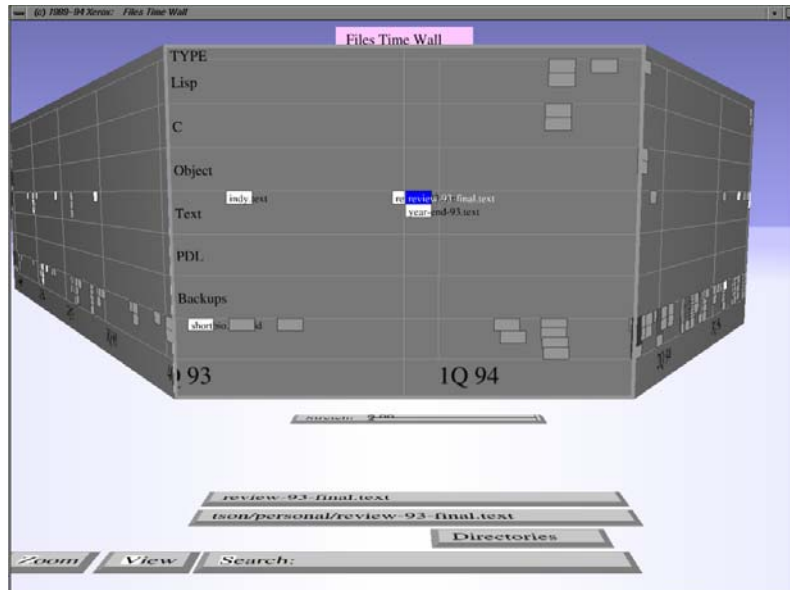


Image from "Information Visualization" by Robert Spence

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The Perspective Wall



Mackinlay / Robertson / Card: Proc ACM CHI'91

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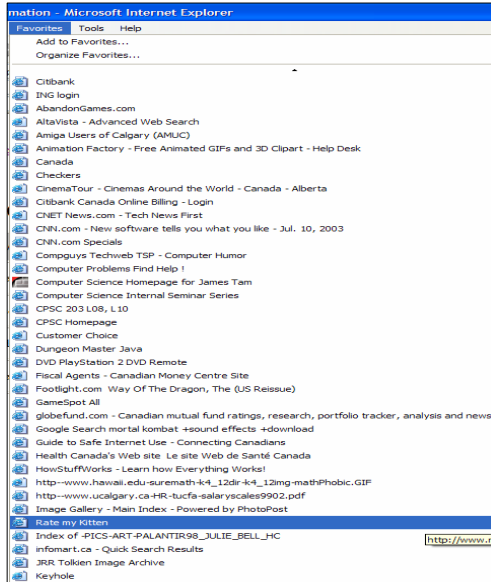
Another Example Of The “Large Data Set – Limited Display Space Problem” : Lists

Approaches to mitigating the problem:

- Scrolling
- Setting up hierarchies
- Fisheye

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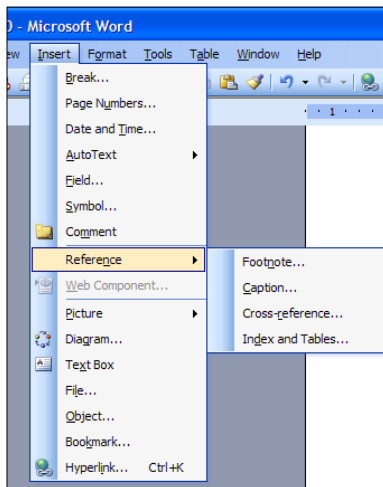
Scrolling Menus



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Hierarchical Menus

Works well for goal directed tasks (e.g., selecting from a menu of functions that are familiar).



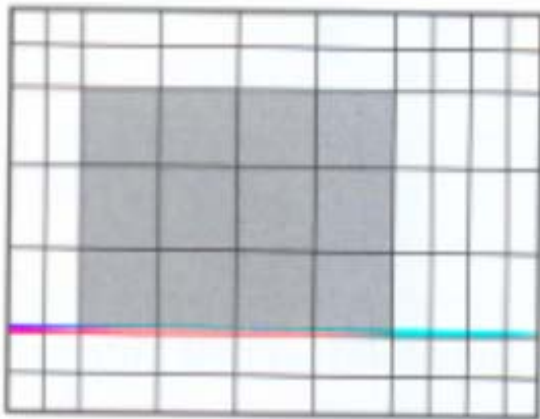
Word © Microsoft

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| | | |
|----------|---|--|
| F | Fisheye | |
| A | <ul style="list-style-type: none"> Allegro Allegro 5 Allegro 6 Allegro 7 Allegro 8 Allegro 9 Allegro 10 Allegro 11 Allegro 12 Allegro 13 Allegro 14 Allegro 15 Allegro 16 Allegro 17 Allegro 18 Allegro 19 Allegro 20 Allegro 21 Allegro 22 Allegro 23 Allegro 24 Allegro 25 Allegro 26 Allegro 27 Allegro 28 Allegro 29 Allegro 30 Allegro 31 Allegro 32 Allegro 33 Allegro 34 Allegro 35 Allegro 36 Allegro 37 Allegro 38 Allegro 39 Allegro 40 Allegro 41 Allegro 42 Allegro 43 Allegro 44 Allegro 45 Allegro 46 Allegro 47 Allegro 48 Allegro 49 Allegro 50 Allegro 51 Allegro 52 Allegro 53 Allegro 54 Allegro 55 Allegro 56 Allegro 57 Allegro 58 Allegro 59 Allegro 60 Allegro 61 Allegro 62 Allegro 63 Allegro 64 Allegro 65 Allegro 66 Allegro 67 Allegro 68 Allegro 69 Allegro 70 Allegro 71 Allegro 72 Allegro 73 Allegro 74 Allegro 75 Allegro 76 Allegro 77 Allegro 78 Allegro 79 Allegro 80 Allegro 81 Allegro 82 Allegro 83 Allegro 84 Allegro 85 Allegro 86 Allegro 87 Allegro 88 Allegro 89 Allegro 90 Allegro 91 Allegro 92 Allegro 93 Allegro 94 Allegro 95 Allegro 96 Allegro 97 Allegro 98 Allegro 99 Allegro 100 | |
| B | <ul style="list-style-type: none"> Baidu Baidu 2 Baidu 3 Baidu 4 Baidu 5 Baidu 6 Baidu 7 Baidu 8 Baidu 9 Baidu 10 Baidu 11 Baidu 12 Baidu 13 Baidu 14 Baidu 15 Baidu 16 Baidu 17 Baidu 18 Baidu 19 Baidu 20 Baidu 21 Baidu 22 Baidu 23 Baidu 24 Baidu 25 Baidu 26 Baidu 27 Baidu 28 Baidu 29 Baidu 30 Baidu 31 Baidu 32 Baidu 33 Baidu 34 Baidu 35 Baidu 36 Baidu 37 Baidu 38 Baidu 39 Baidu 40 Baidu 41 Baidu 42 Baidu 43 Baidu 44 Baidu 45 Baidu 46 Baidu 47 Baidu 48 Baidu 49 Baidu 50 Baidu 51 Baidu 52 Baidu 53 Baidu 54 Baidu 55 Baidu 56 Baidu 57 Baidu 58 Baidu 59 Baidu 60 Baidu 61 Baidu 62 Baidu 63 Baidu 64 Baidu 65 Baidu 66 Baidu 67 Baidu 68 Baidu 69 Baidu 70 Baidu 71 Baidu 72 Baidu 73 Baidu 74 Baidu 75 Baidu 76 Baidu 77 Baidu 78 Baidu 79 Baidu 80 Baidu 81 Baidu 82 Baidu 83 Baidu 84 Baidu 85 Baidu 86 Baidu 87 Baidu 88 Baidu 89 Baidu 90 Baidu 91 Baidu 92 Baidu 93 Baidu 94 Baidu 95 Baidu 96 Baidu 97 Baidu 98 Baidu 99 Baidu 100 | |
| C | <ul style="list-style-type: none"> Cisco Cisco 2 Cisco 3 Cisco 4 Cisco 5 Cisco 6 Cisco 7 Cisco 8 Cisco 9 Cisco 10 Cisco 11 Cisco 12 Cisco 13 Cisco 14 Cisco 15 Cisco 16 Cisco 17 Cisco 18 Cisco 19 Cisco 20 Cisco 21 Cisco 22 Cisco 23 Cisco 24 Cisco 25 Cisco 26 Cisco 27 Cisco 28 Cisco 29 Cisco 30 Cisco 31 Cisco 32 Cisco 33 Cisco 34 Cisco 35 Cisco 36 Cisco 37 Cisco 38 Cisco 39 Cisco 40 Cisco 41 Cisco 42 Cisco 43 Cisco 44 Cisco 45 Cisco 46 Cisco 47 Cisco 48 Cisco 49 Cisco 50 Cisco 51 Cisco 52 Cisco 53 Cisco 54 Cisco 55 Cisco 56 Cisco 57 Cisco 58 Cisco 59 Cisco 60 Cisco 61 Cisco 62 Cisco 63 Cisco 64 Cisco 65 Cisco 66 Cisco 67 Cisco 68 Cisco 69 Cisco 70 Cisco 71 Cisco 72 Cisco 73 Cisco 74 Cisco 75 Cisco 76 Cisco 77 Cisco 78 Cisco 79 Cisco 80 Cisco 81 Cisco 82 Cisco 83 Cisco 84 Cisco 85 Cisco 86 Cisco 87 Cisco 88 Cisco 89 Cisco 90 Cisco 91 Cisco 92 Cisco 93 Cisco 94 Cisco 95 Cisco 96 Cisco 97 Cisco 98 Cisco 99 Cisco 100 | |
| D | <ul style="list-style-type: none"> Dell Dell 2 Dell 3 Dell 4 Dell 5 Dell 6 Dell 7 Dell 8 Dell 9 Dell 10 Dell 11 Dell 12 Dell 13 Dell 14 Dell 15 Dell 16 Dell 17 Dell 18 Dell 19 Dell 20 Dell 21 Dell 22 Dell 23 Dell 24 Dell 25 Dell 26 Dell 27 Dell 28 Dell 29 Dell 30 Dell 31 Dell 32 Dell 33 Dell 34 Dell 35 Dell 36 Dell 37 Dell 38 Dell 39 Dell 40 Dell 41 Dell 42 Dell 43 Dell 44 Dell 45 Dell 46 Dell 47 Dell 48 Dell 49 Dell 50 Dell 51 Dell 52 Dell 53 Dell 54 Dell 55 Dell 56 Dell 57 Dell 58 Dell 59 Dell 60 Dell 61 Dell 62 Dell 63 Dell 64 Dell 65 Dell 66 Dell 67 Dell 68 Dell 69 Dell 70 Dell 71 Dell 72 Dell 73 Dell 74 Dell 75 Dell 76 Dell 77 Dell 78 Dell 79 Dell 80 D | |

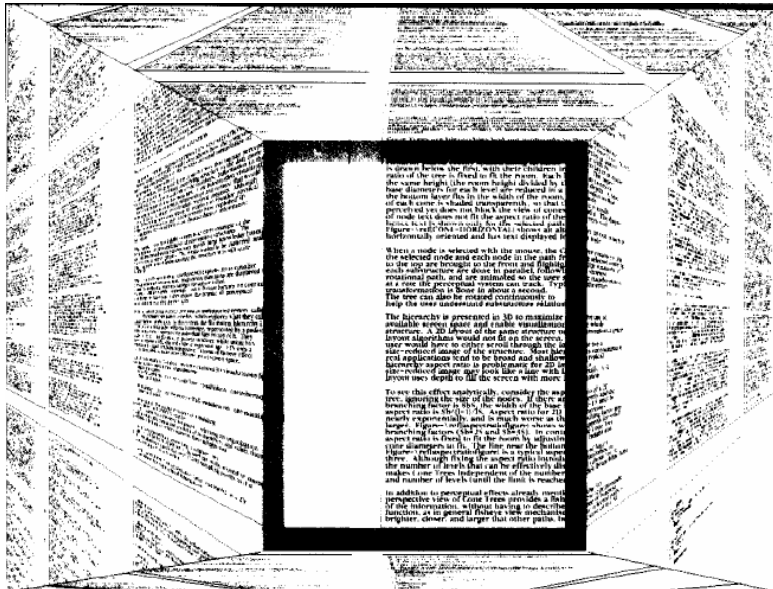
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- **Distortion in both the X and Y dimensions**



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DocumentLens



Robertson / Mackinlay ACM UIST 1993

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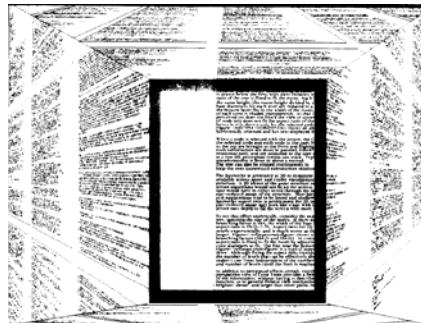
DocumentLens: The Details

Recall:

- The Perspective Wall can only be used when the data is structured into different categories.
- Laying out a complete overview of a large dataset is not feasible.

DocumentLens:

- Can be used when the data is not organized.
- Portions of the data can viewed in greater detail while the surrounding context can still be seen.



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The DateLens



Detailed
calendar
view of one
day (focus)

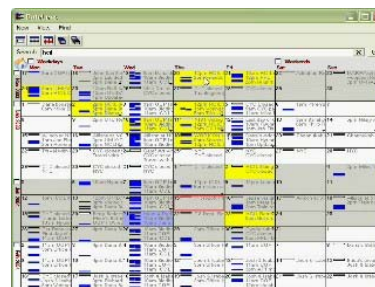
Abstracted
calendar
information of
other days and
times (context)

The DateLens: HCIL (University of Maryland) and Microsoft Research

James Tam

The DateLens: The Details

- Combines a fisheye view of calendar information with zooming (zui's)
- The fisheye view can be distorted to increase the 'weight' of particular information.
- Integrated searching
 - Results show up in greater detail in the area of focus
 - Results also show up in an abstracted form in the contextual view
- Zooming
 - Double headed scrollbar can be used to zoom in or out of the calendar
 - Automatic rescaling of the detailed view



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Fisheye vs. Separate (Overhead And Detail) Views

Separate



Fisheye

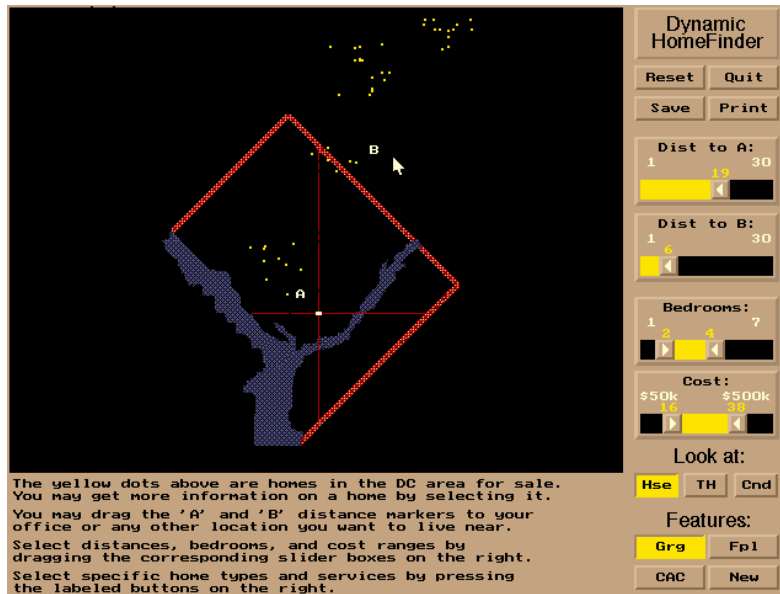


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Visual Information-Seeking Mantra

- Overview first, zoom and filter, then details on demand
- Overview first, zoom and filter, then details on demand
- Overview first, zoom and filter, then details on demand
- Overview first, zoom and filter, then details on demand
- Overview first, zoom and filter, then details on demand
- Overview first, zoom and filter, then details on demand
- Overview first, zoom and filter, then details on demand
- Overview first, zoom and filter, then details on demand
- Overview first, zoom and filter, then details on demand
- Overview first, zoom and filter, then details on demand
- Overview first, zoom and filter, then details on demand

Dynamic Queries: HomeFinder



Shneiderman et al University of Maryland <http://www.cs.umd.edu/hcil/spotfire/>

James Tam

HomeFinder: The Details

Start with an overview of the data

- All query results may all appear in an abstracted form

Dynamic queries (rapid, incremental, reversible actions to filter the data)

- All query results are displayed instantly
- No “search button”
- Prevents errors

Direct manipulation of

- Queries
- Query results
- Can be interacted with like real-world objects

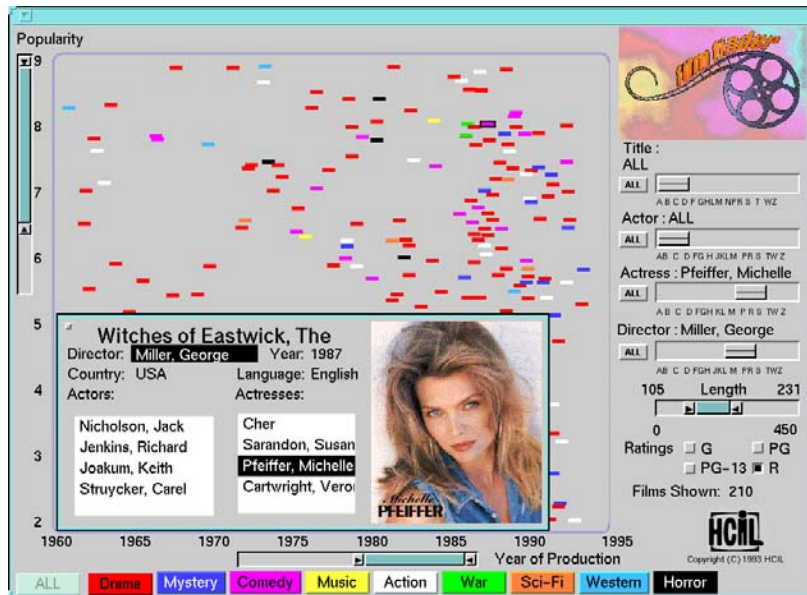
Details on Demand

- Additional information can be provided about each query result



James Tam

Starfield Display: FilmFinder



Ahlberg, University of Maryland <http://www.cs.umd.edu/hcil/spotfire/>

James Tam

FilmFinder: The Details

Filmfinder employs many of the principles employed in the HomeFinder:

- Overview of the data
- Filtering query results through
 - Dynamic queries
 - Direct manipulation
- Details on demand

But with FilmFinder system there are additional concepts:

- Zooming in on the data set.
 - When the number of query results is small additional details are provided about each result (thumbnails and text)
- Starfield display
 - The entire data base can be viewed and manipulated on one screen with meaning attached to each dimensions.
- Tight coupling of interface components (to the state of the system)



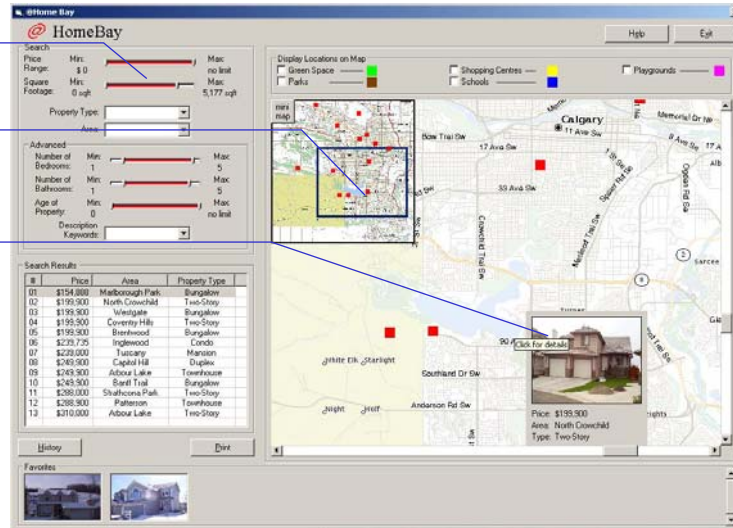
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A Student Project: HomeBay

Dynamic
Queries

Radar
Overview

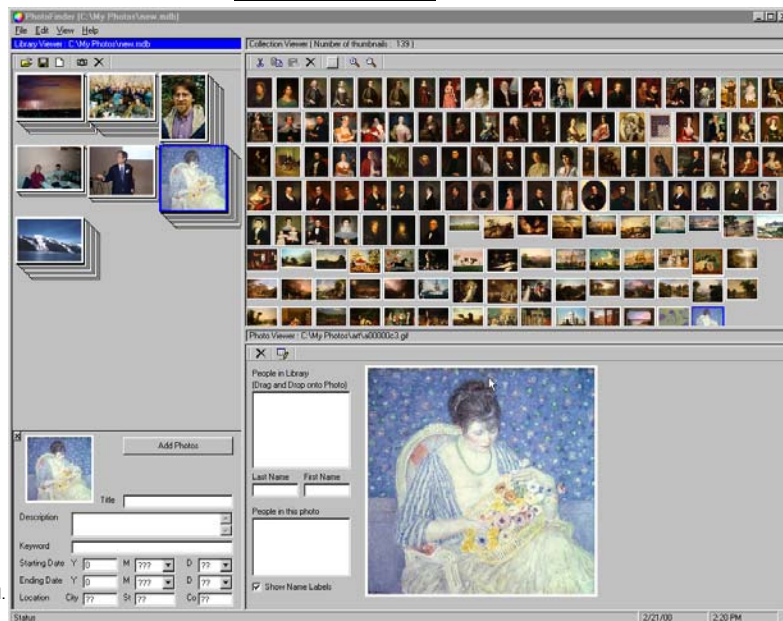
Progressive
details on
demand



481 Student Project (April, 2000) Rob Pearson, Kashama Willms and James Chisan

James Tam

PhotoFinder



University of
Maryland
Human Computer
Interaction
Laboratory
<http://www.cs.umd.edu/hcil/>

James Tam

PhotoFinder: The Details

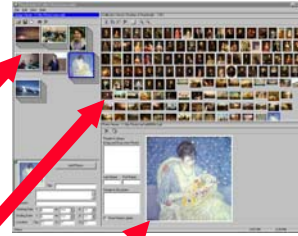
Multiple Views Of A Large Data Set:

- 3 levels of detail

Library view

Collection view

Photo view



James Tam

PhotoFinder: The Details (2)

Allows for the annotation of each photo with pertinent information (“tagging”)

A screenshot of the PhotoFinder application's annotation form. The form is titled 'Add Photos' and contains several input fields for metadata. On the left, there is a small thumbnail of a photo. The form fields include: 'Description' (text area), 'Keyword' (text area), 'Starting Date' (Y, M, D dropdowns), 'Ending Date' (Y, M, D dropdowns), 'Location' (City, St, Co dropdowns), and 'Status' (text area). On the right, there is a section titled 'People in Library (Drag and Drop onto Photo)' with a list box for 'Last Name' and 'First Name'. Below this is a section titled 'People in this photo' with a list box. A checkbox labeled 'Show Name Labels' is checked.

James Tam

Representing Connectivity

- **The problem of having large data set – but limited display space must still be dealt with**
- **Also there is the additional problem of showing how things in a large data set relate**
 - e.g., How do we show Internet connections between servers?
- **Some issues:**
 - Occlusion of information
 - Edge crossing
 - Overwhelming quantity of edges

James Tam

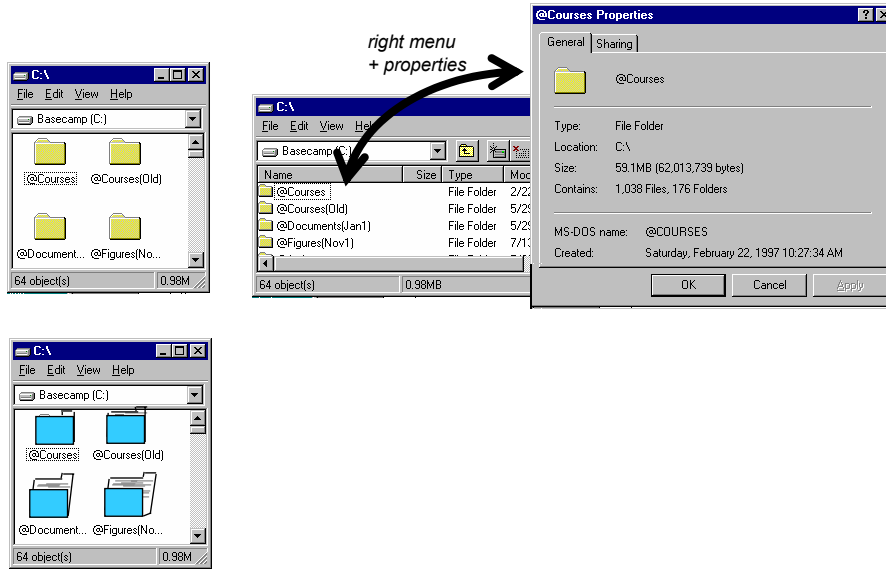
Representing Phone Network Connections



Images from "Information Visualization" by Robert Spence

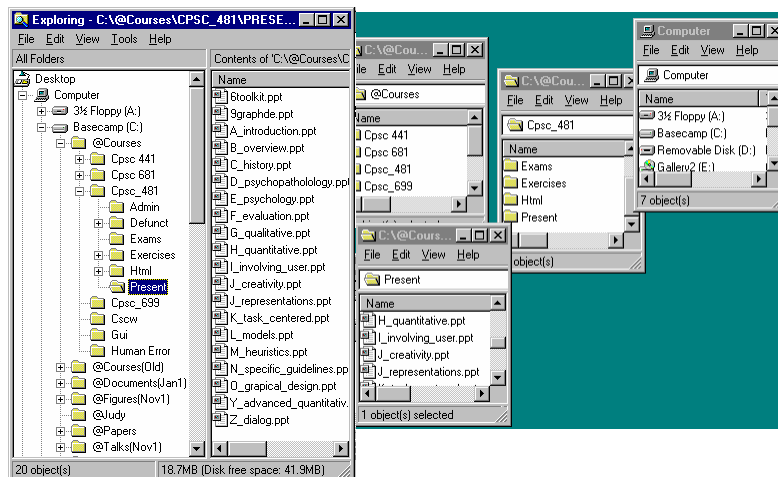
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Which Folder Has The Most Documents?



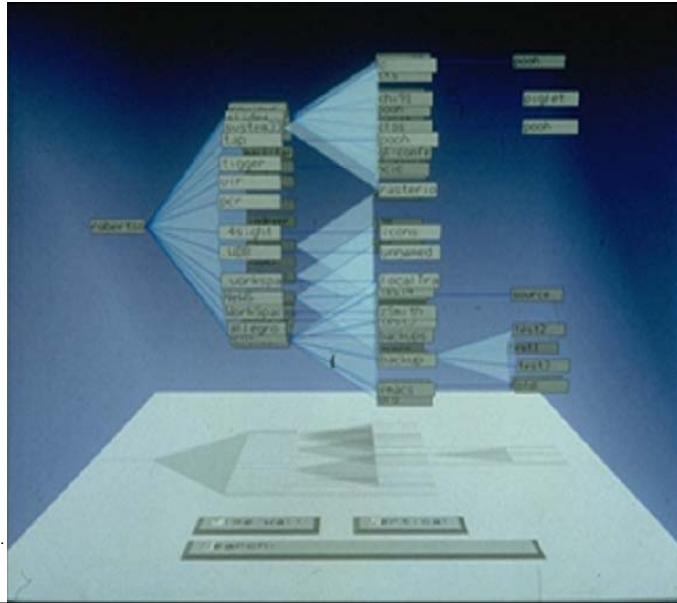
James Tam

Where Am I? Where Was I Going?



James Tam

Cone Trees

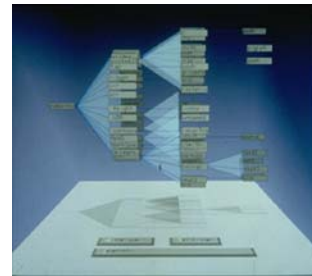


Robertson / Mackinlay /
Card
Cone Trees: Animated
3D Visualizations of
Hierarchical Information.
Proc ACM CHI'91

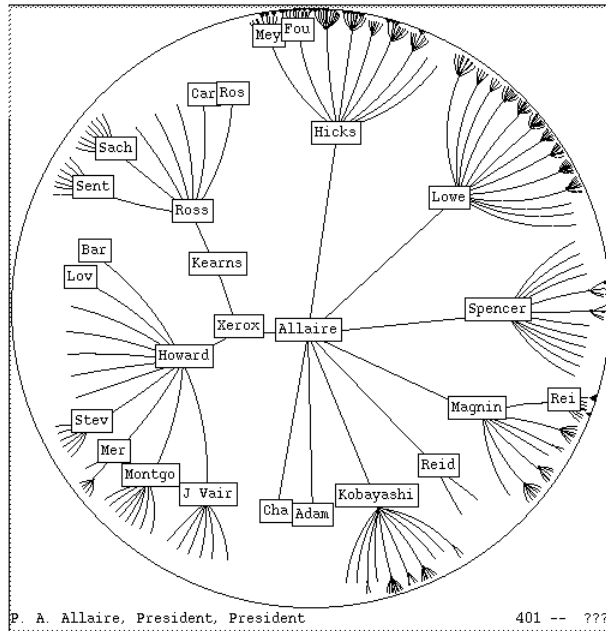
James Tam

Cone Trees: The Details

- **Employs 3D in order to more efficiently represent the data and their relationships.**
 - Used to represent complex hierarchies
 - To mitigate the effect of occlusion transparency is employed
- **Fisheye effects are used to highlight nodes.**
- **Dynamic filtering of the tree.**
- **Animates the display to help the user to interpret results.**



James Tam

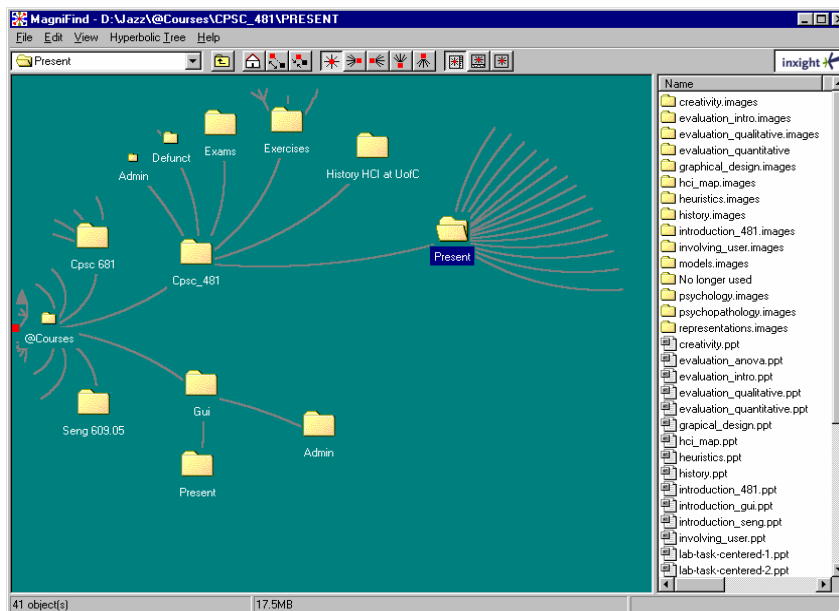


Xerox Parc/Inxight

Demo: <http://starttree.inxight.com/>

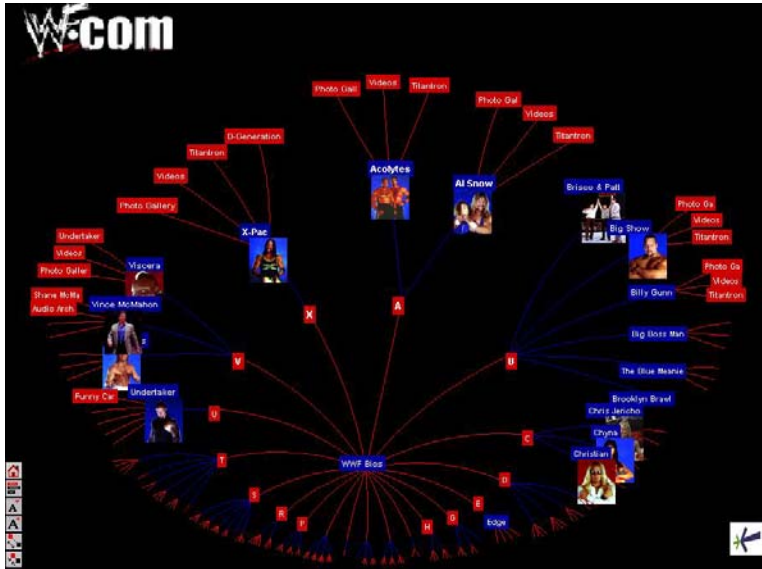
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Hyperbolic View Of A Disk Hierarchy



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Hyperbolic View Of The Web



Demo:<http://startree.inxight.com/>

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What You Now Know

Ways of dealing with the “large data set but limited display space” problem

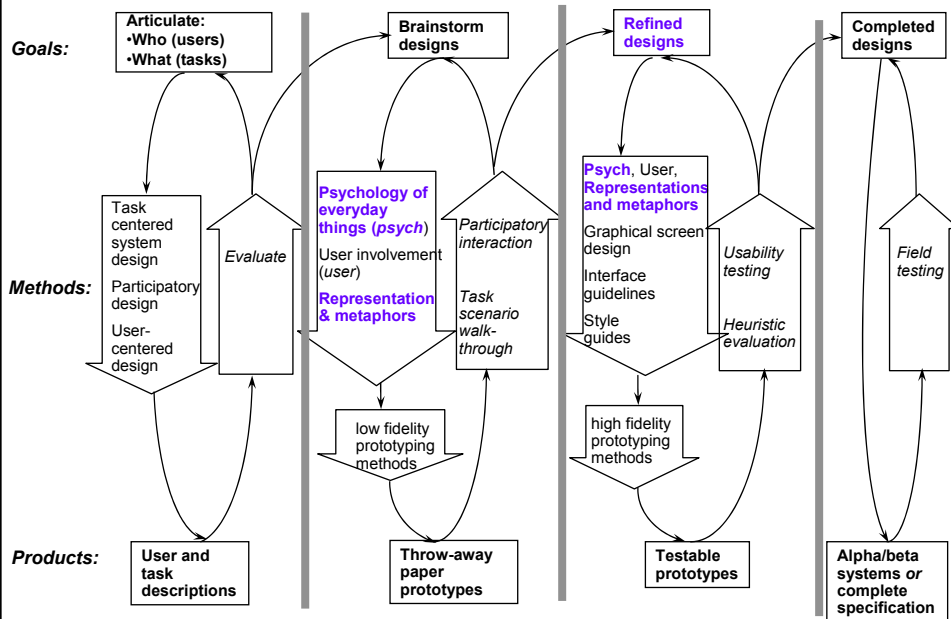
- Scrolling
- Magnification
- The DragMag
- Transparent overlays
- Overview and detail
- Focus and context
- Zooming

The information seeking mantra and how it has been applied in the HomeFinder and FilmFinder systems

Problems and some solutions when representing connectivity in large data sets

James Tam

Interface Design And Usability Engineering



This diagram is a variation of the one presented by Saul Greenberg

James Tam