

Representations and information visualization

Characteristics of good representations

Information visualization

guidelines

visual information-seeking mantra

techniques

Good representations

captures essential elements of the event / world
deliberately leaves out / mutes the irrelevant
appropriate for the person and their interpretation
appropriate for the task, enhancing judgment ability

How many buffalo?



||||| |||| ||

Buffalo

||||| |||| ||

Buffalo

||||| |||

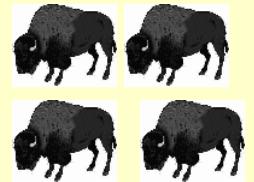
Adults

||||

calfs

8

4



Representation

Representations

- formal system or mapping by which information can be specified
- a sign system in that it stands for something other than its self.

for example:

decimal: 34,
binary: 100010,
roman: XXXIV

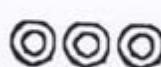
different representations reveal different aspects of the information

decimal: counting & information about powers of 10,
binary: counting & information about powers of 2,
roman: counting

presentation

how the representation is placed or organized on the screen

34, 34, 34



Zero

One

Two

Three

Four



Five



Six



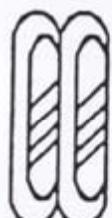
Seven



Eight



Nine



Ten



Eleven



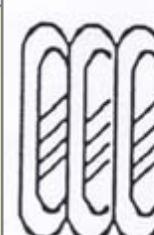
Twelve



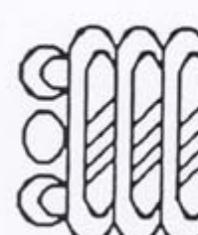
Thirteen



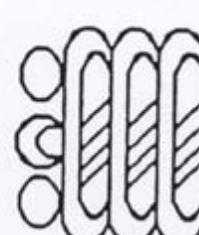
Fourteen



Fifteen



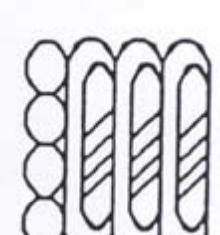
Sixteen



Seventeen



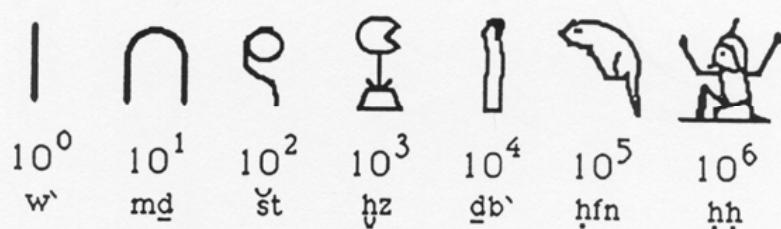
Eighteen



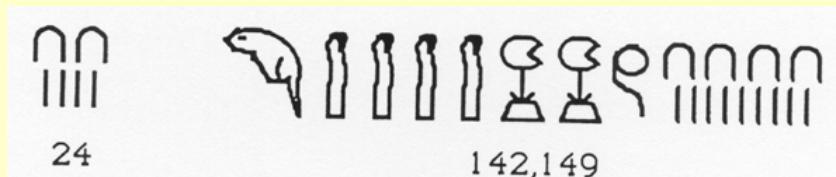
Nineteen

Mayan Numerals one to nineteen

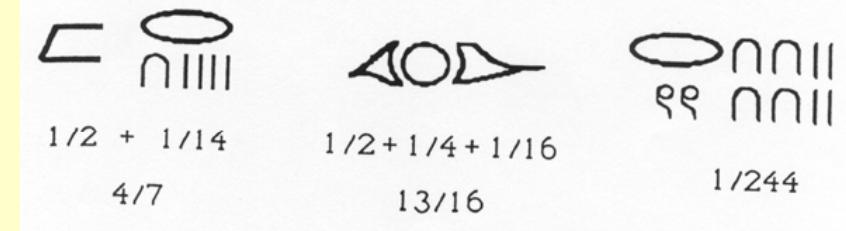
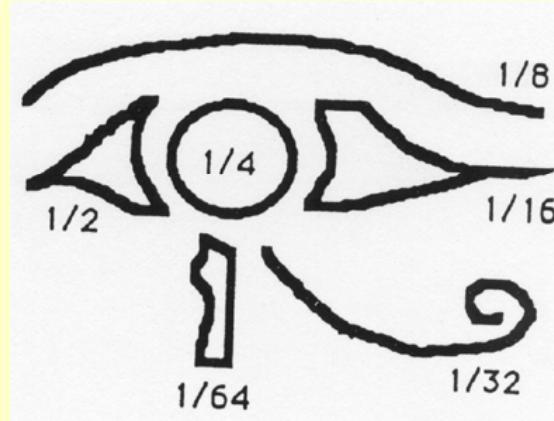
Egyptian Numerals



Egyptian cardinal icons.



Sample Egyptian numbers.



Sample Egyptian fractions.

Representations

Solving a problem simply means representing it so as to make the solution transparent

(Simon, 1981)

Good representations

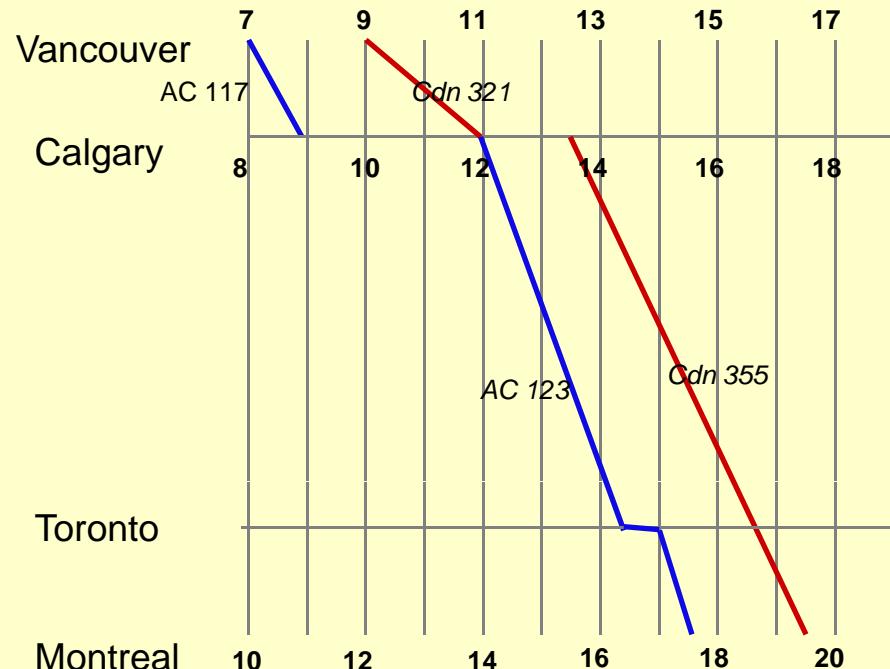
- allow people to find relevant information
 - information may be present but hard to find
- allow people to compute desired conclusions
 - computations may be difficult or “for free” depending on representations

Which is the best flight?

length
stop-overs
switches...

			depart	arrive
AC 117	Vancouver - Calgary		7:00	9:00
Cdn 321	Vancouver - Calgary		9:00	12:00
Cdn 355	Calgary - Montreal		13:30	19:30
AC 123	Calgary - Toronto		12:30	16:30
AC 123	Toronto - Montreal		16:45	17:30

*time zone: +1 van-cal, +2 cal-tor, mtl



When do I take my drugs?

10 - 30% error rate in taking pills, same for pillbox organizers

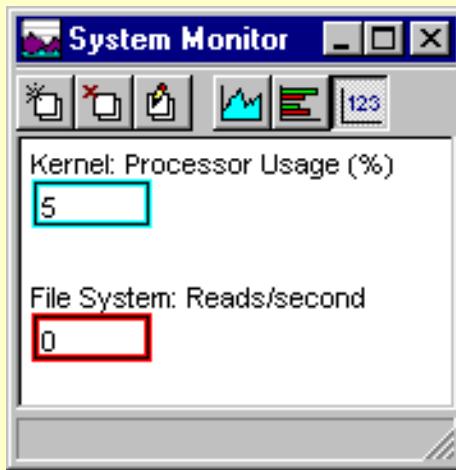
- | | | |
|----------|---|---------------------------------------|
| Inderal | - | 1 tablet 3 times a day |
| Lanoxin | - | 1 tablet every a.m. |
| Carafate | - | 1 tablet before meals and at bedtime |
| Zantac | - | 1 tablet every 12 hours (twice a day) |
| Quinag | - | 1 tablet 4 times a day |
| Couma | - | 1 tablet a day |

	Breakfast	Lunch	Dinner	Bedtime
Lanoxin	O			
Inderal	O	O	O	O
Quinag	O	O	O	O
Carafate	O	O	O	O
Zantac		O		O
Couma				O

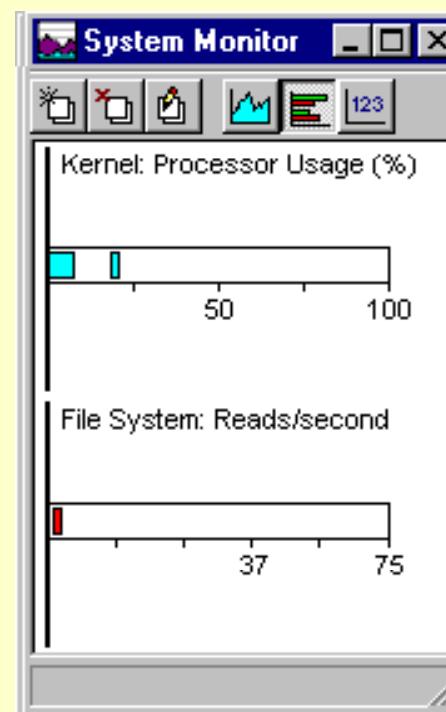
	Breakfast	Lunch	Dinner	Bedtime
Lanoxin				
Inderal		Inderal	Inderal	Inderal
Quinag		Quinag	Quinag	Quinag
Carafate		Carafate	Carafate	Carafate
		Zantac		Zantac
				Couma

Which representation is best?

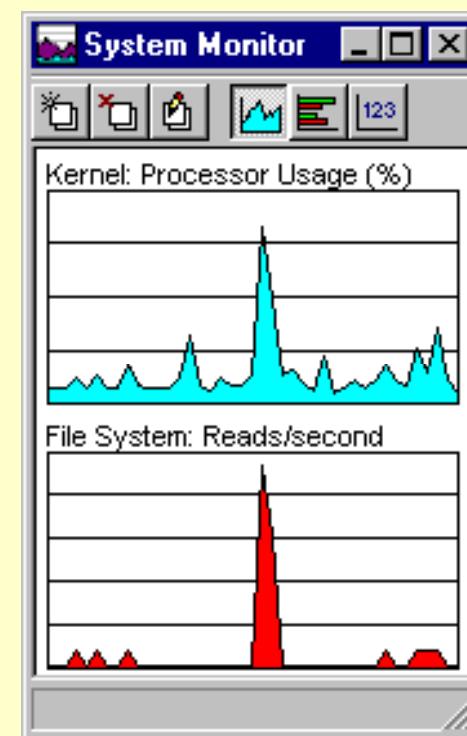
depends heavily on task



What is precise
value?

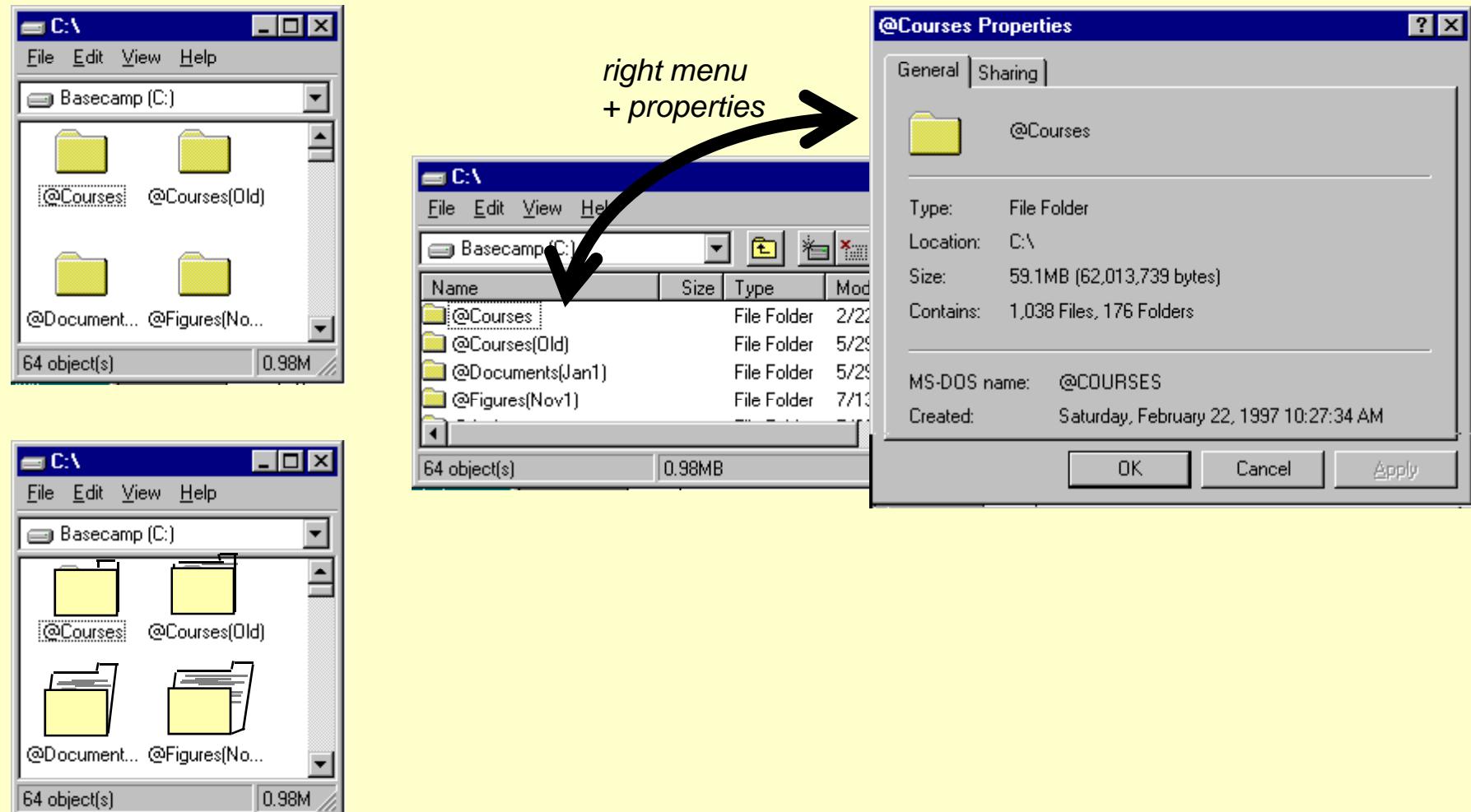


How does the performance
now compared to its peak?



How does performance
change over time?

Which folder has the most documents?



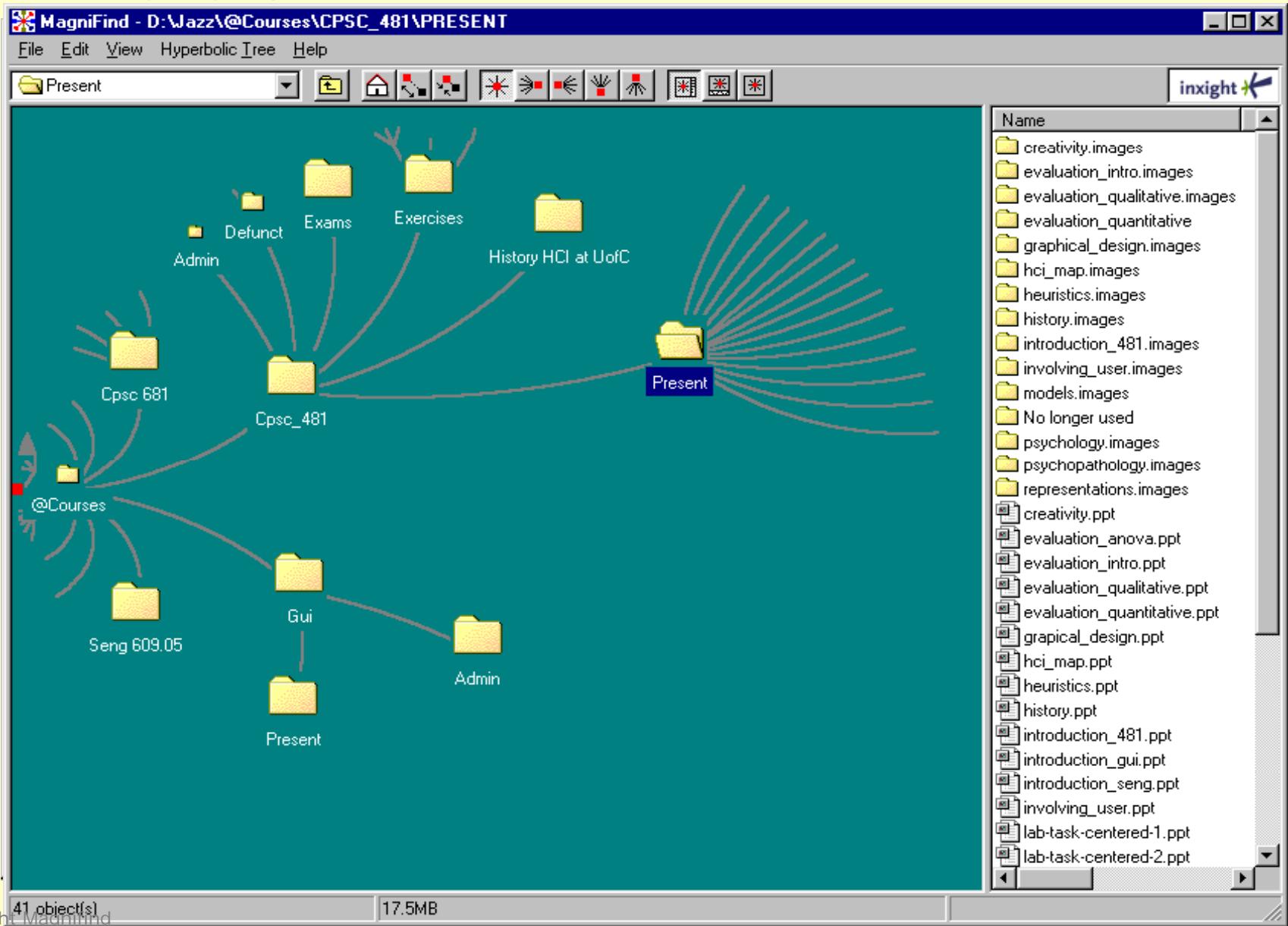
Where am I?

Detailed navigation
plus precision

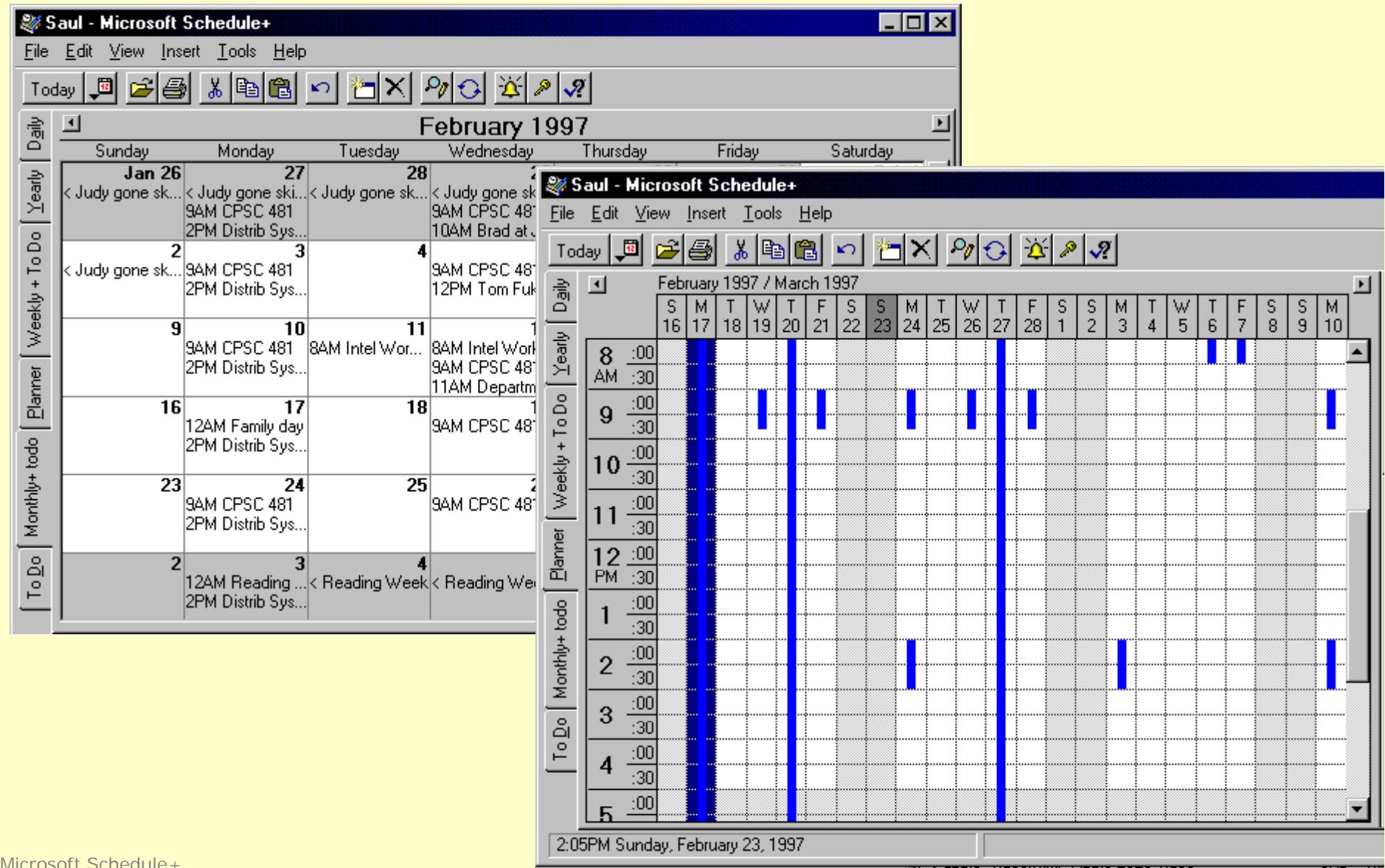


General navigation plus orientation

Where am I?



What do I have to do?



Information Visualization

Graphics should reveal the data

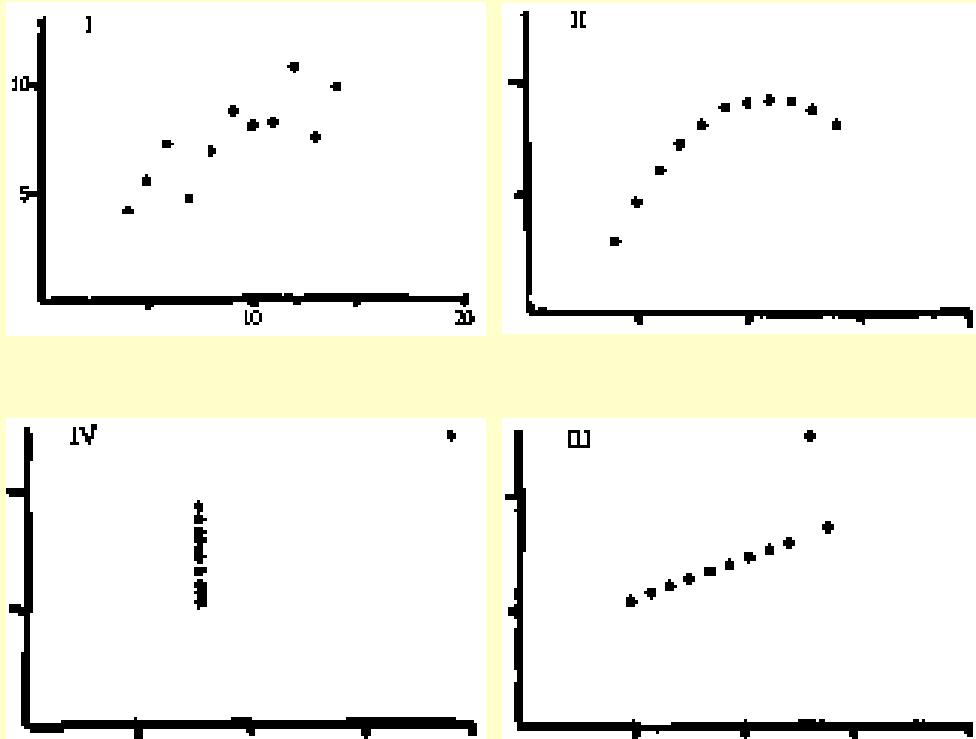
- show the data
- not get in the way of the message
- avoid distortion
- present many numbers in a small space
- make large data sets coherent
- encourage comparison between data
- supply both a broad overview and fine detail
- serve a clear purpose

*E. Tufte
Visual Display of Quantitative Information*

Anscombe's Quartet

I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.57	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.94

N: 11.0
mean X's : 9.0
mean Y's : 7.5
standard error of slope estimate: 0.1
sum of squares: 110.0
regression sum of squares: 27.5
residual sum of squares of Y: 13.8
correlation coefficient: 0.8
r squared: 0.7
regression line: $Y=3+0.5X$



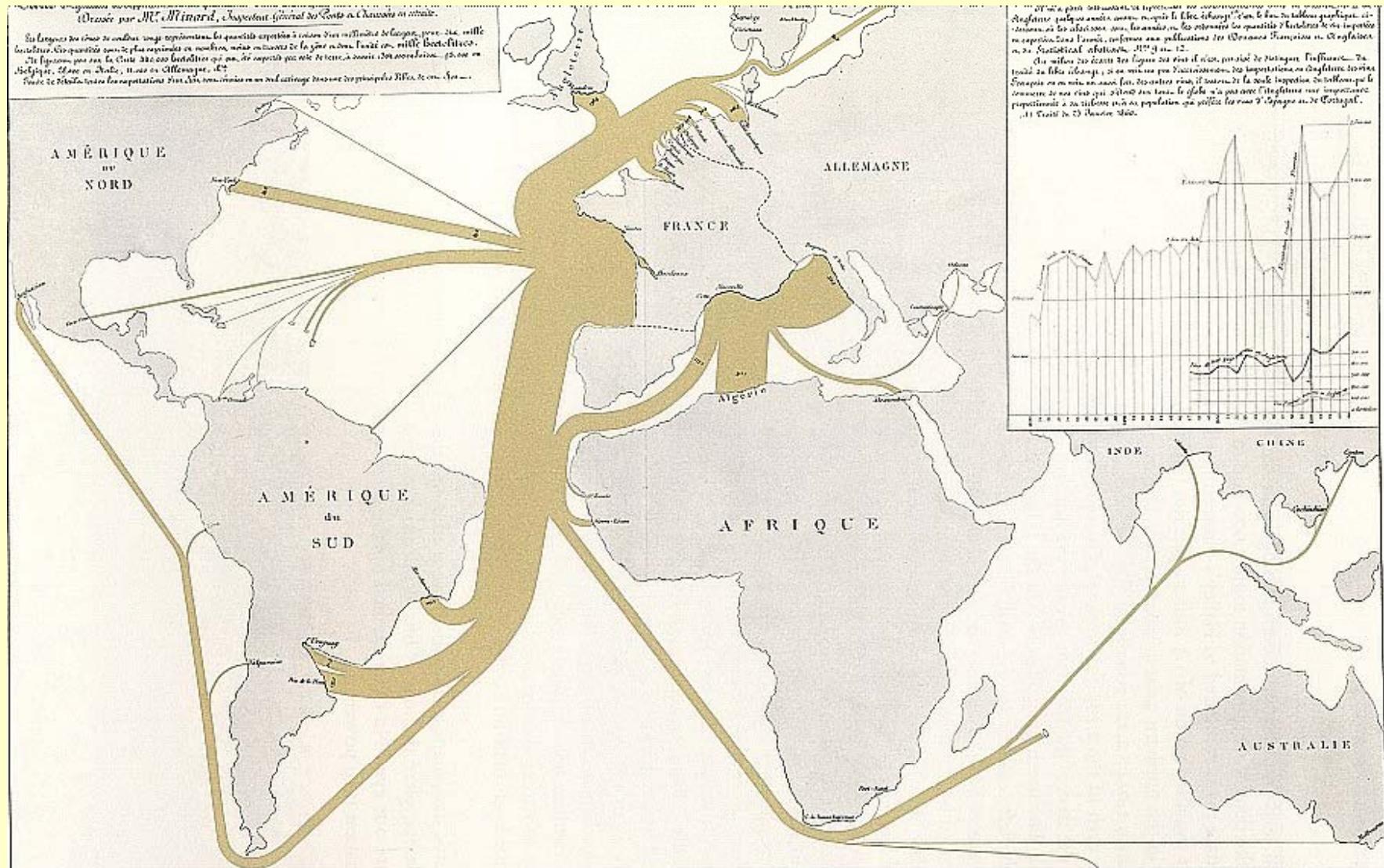
Graphics Reveal the Data

Do I deserve a tax break?

	A	C
1	Market value (*\$1000)	Improvement
2	140.0	31,120.
3	147.0	29,980.
4	151.0	38,120.
5	152.0	34,360.
6	155.0	40,710.
7	170.0	21,620.
8	172.0	42,100.
9	178.0	41,070.
10	180.0	34,210.
11	180.0	44,090.
12	182.0	55,960.
13	185.0	45,170.
14	185.0	46,820.
16	193.4	50,200.
17	194.5	71,860.
18	197.0	48,460.
19	203.0	40,720.
20	205.0	56,600.
21	213.0	42,780.
22	221.0	58,770.
23	225.0	58,960.
24	245.0	48,910.
25	248.0	62,620.
26	278.0	58,580.
27	302.5	72,200.
28	308.0	67,320.



1864 Exports of French Wine



E. Tufte “Visual Display of Quantitative Information” p 25,

Deaths by Cholera

Dr John Snow
1854



Napoleons march to Moscow

by Charles Minard

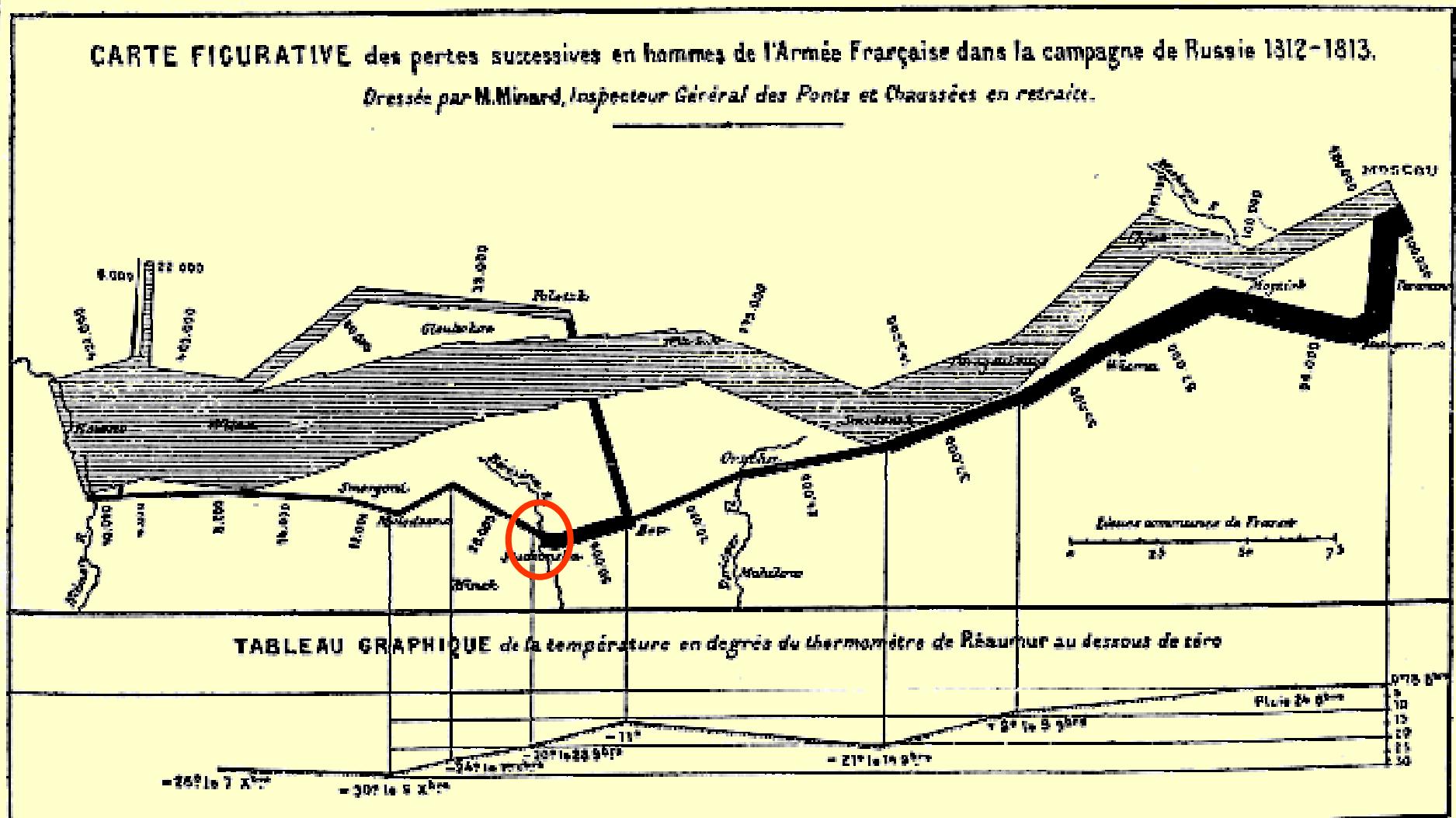


Chart Junk: A common error

Information display is not just pretty graphics

- graphical re-design by amateurs on computers gives us "fontitis," "chart-junk," etc.

Dear **Sir**:

This is a *really exciting* opportunity! Take
advantage of it !

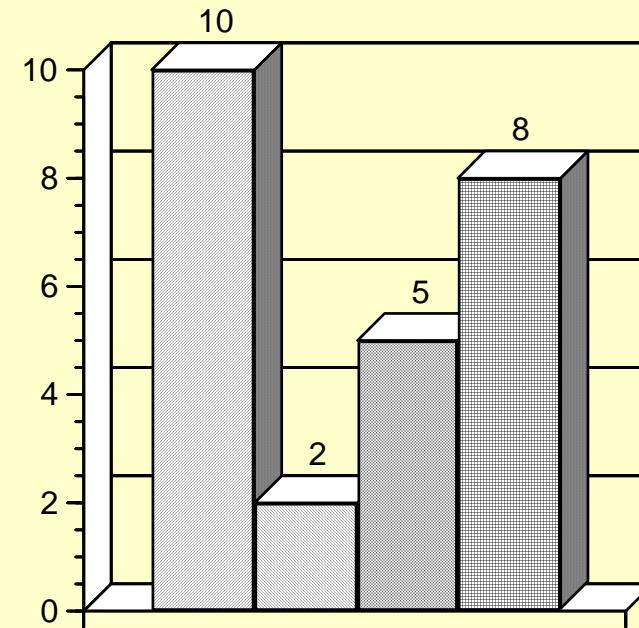


Chart Junk: Cotton production in Brazil, 1927

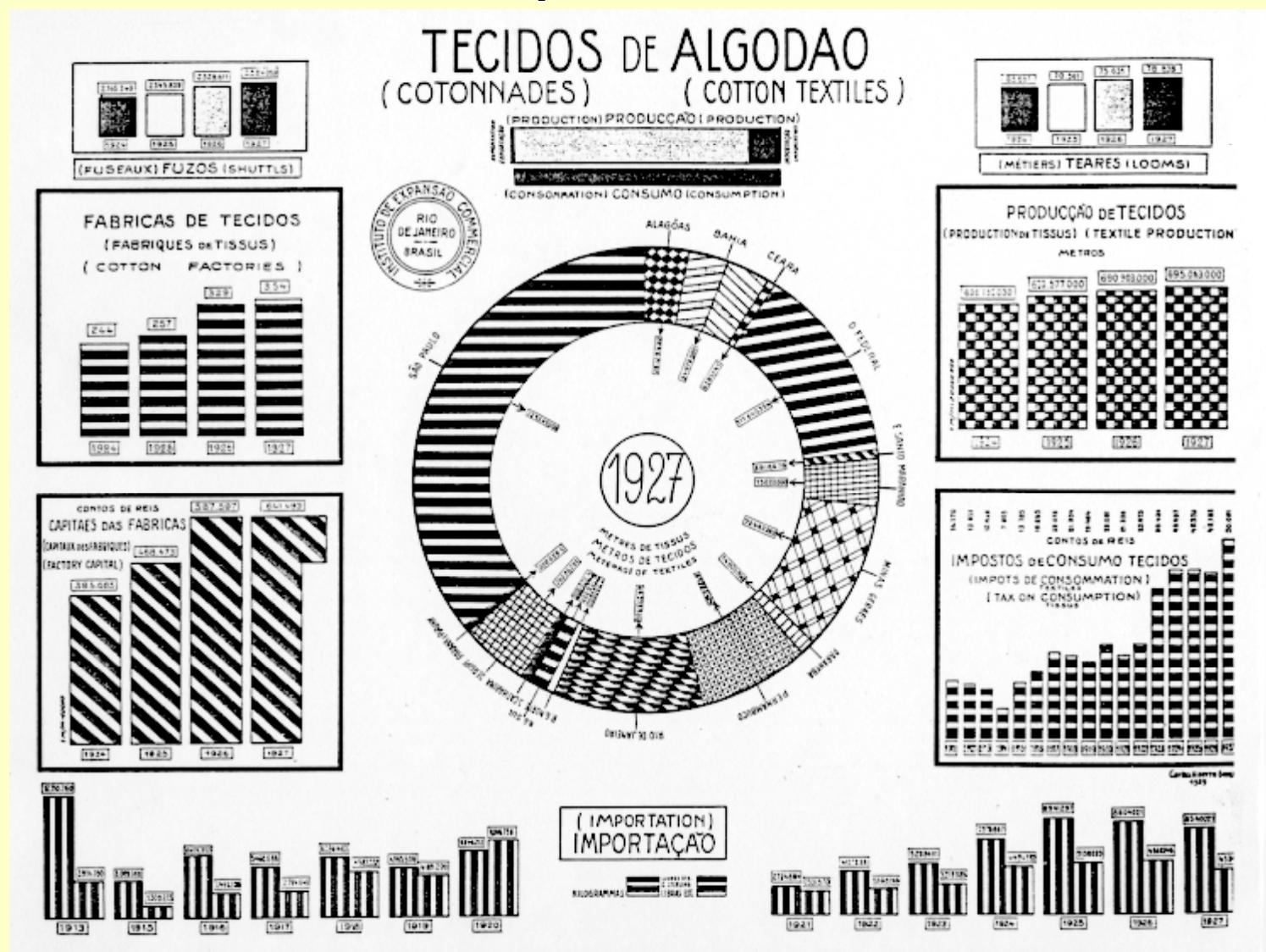
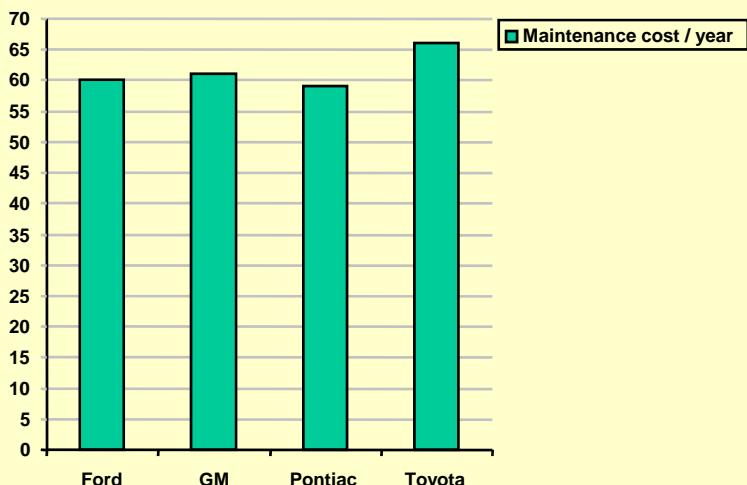
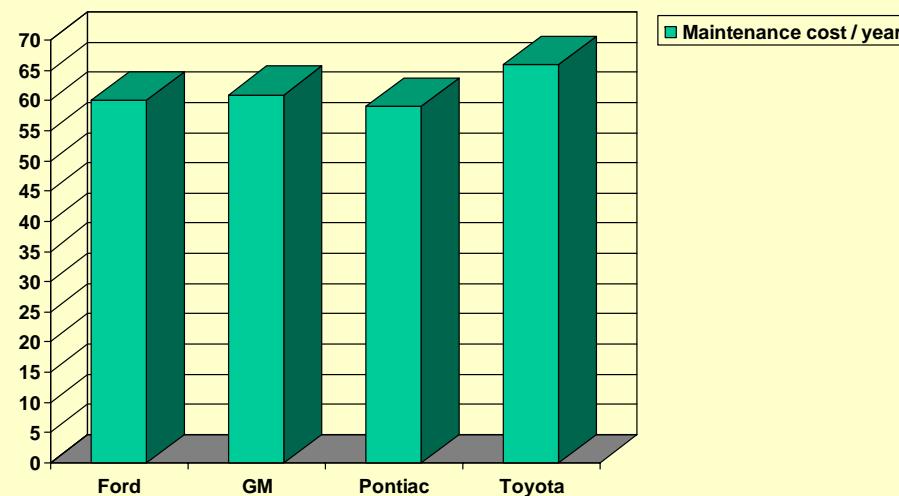
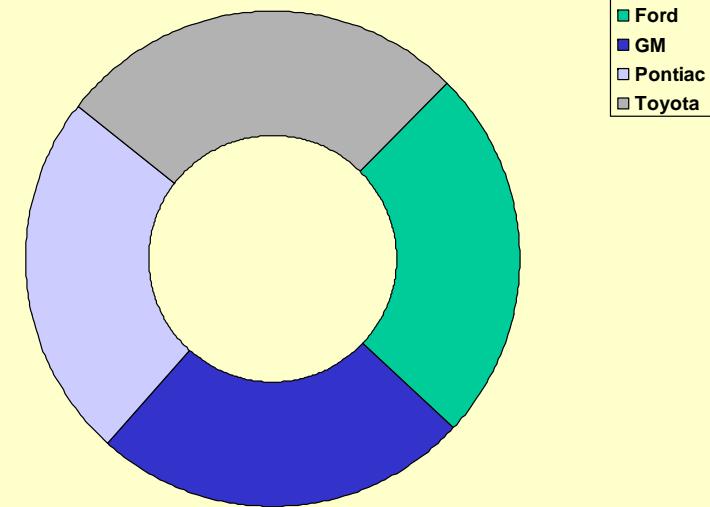
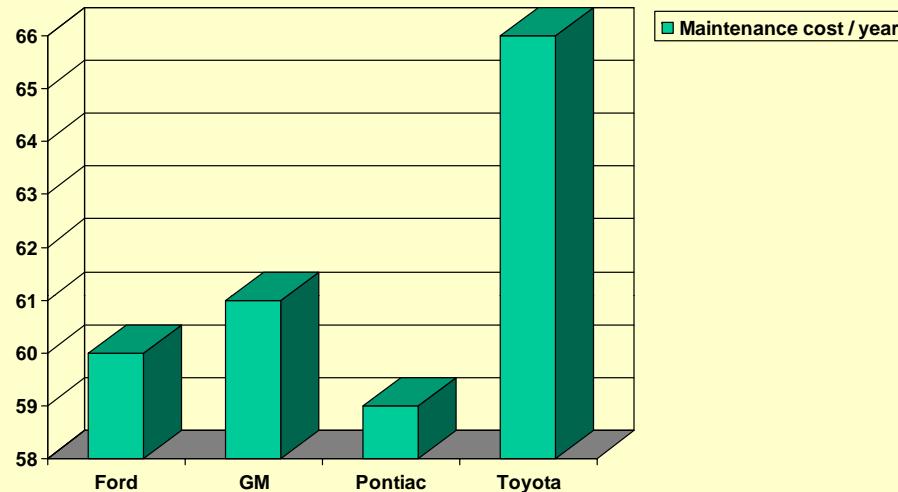


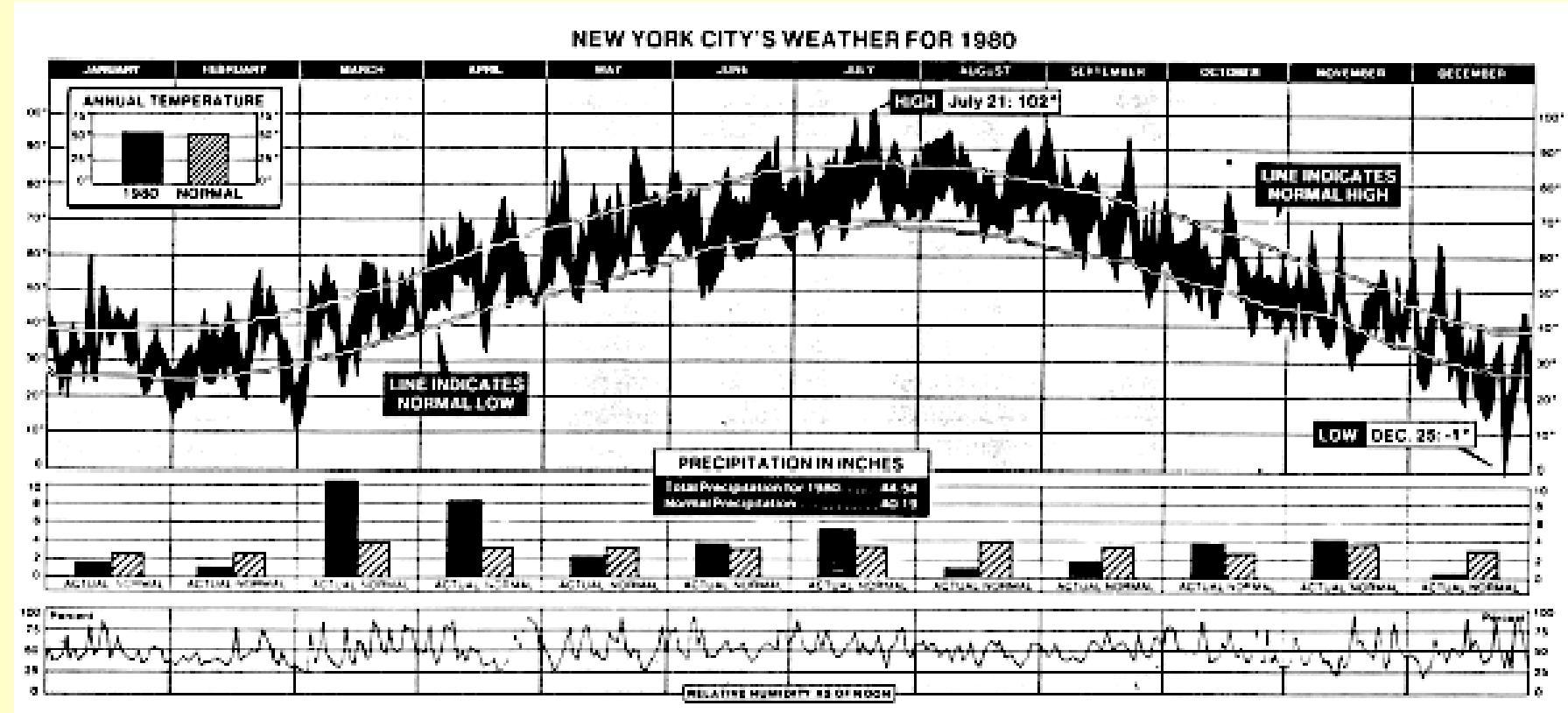
Chart Junk: Removing deception and simplification



Data density

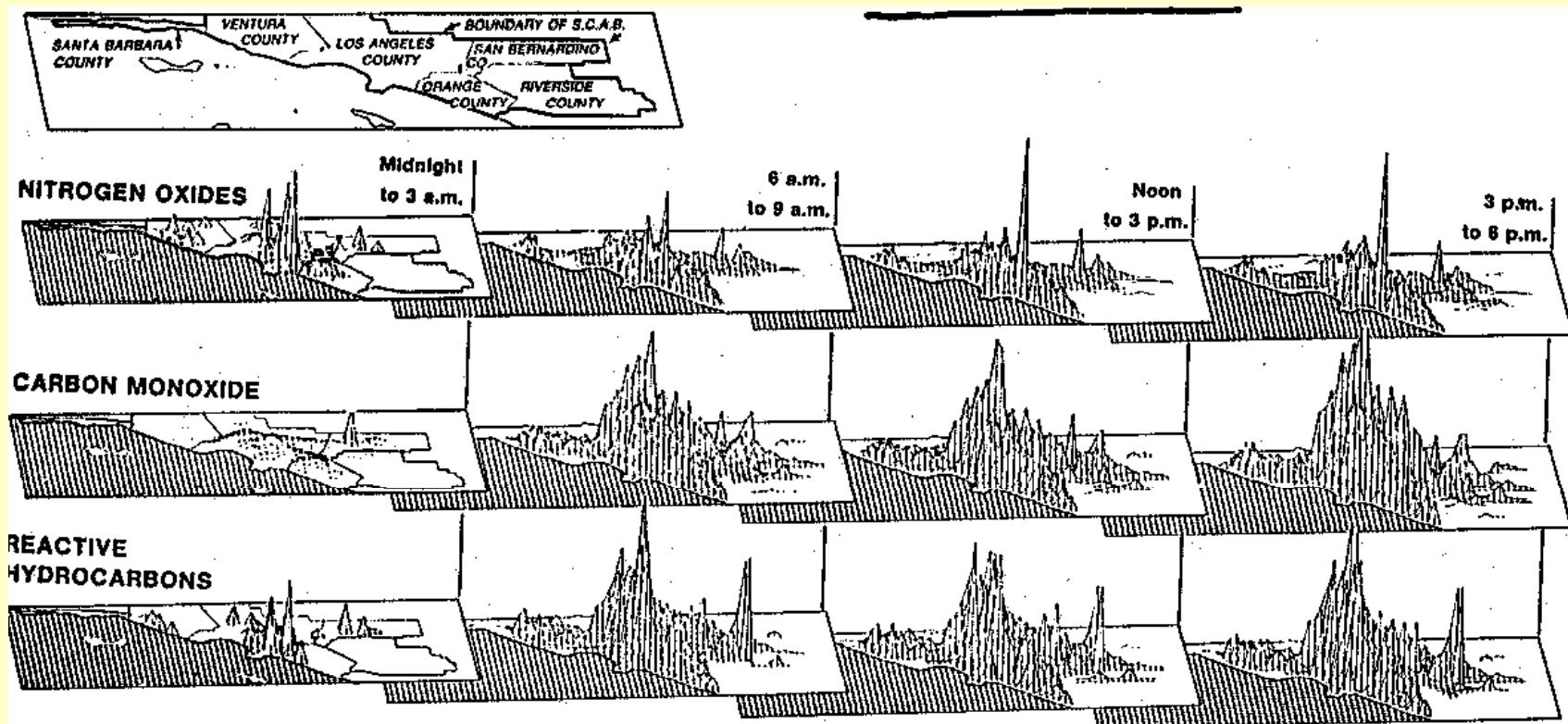
New York Weather History

– 181 numbers/sq inch

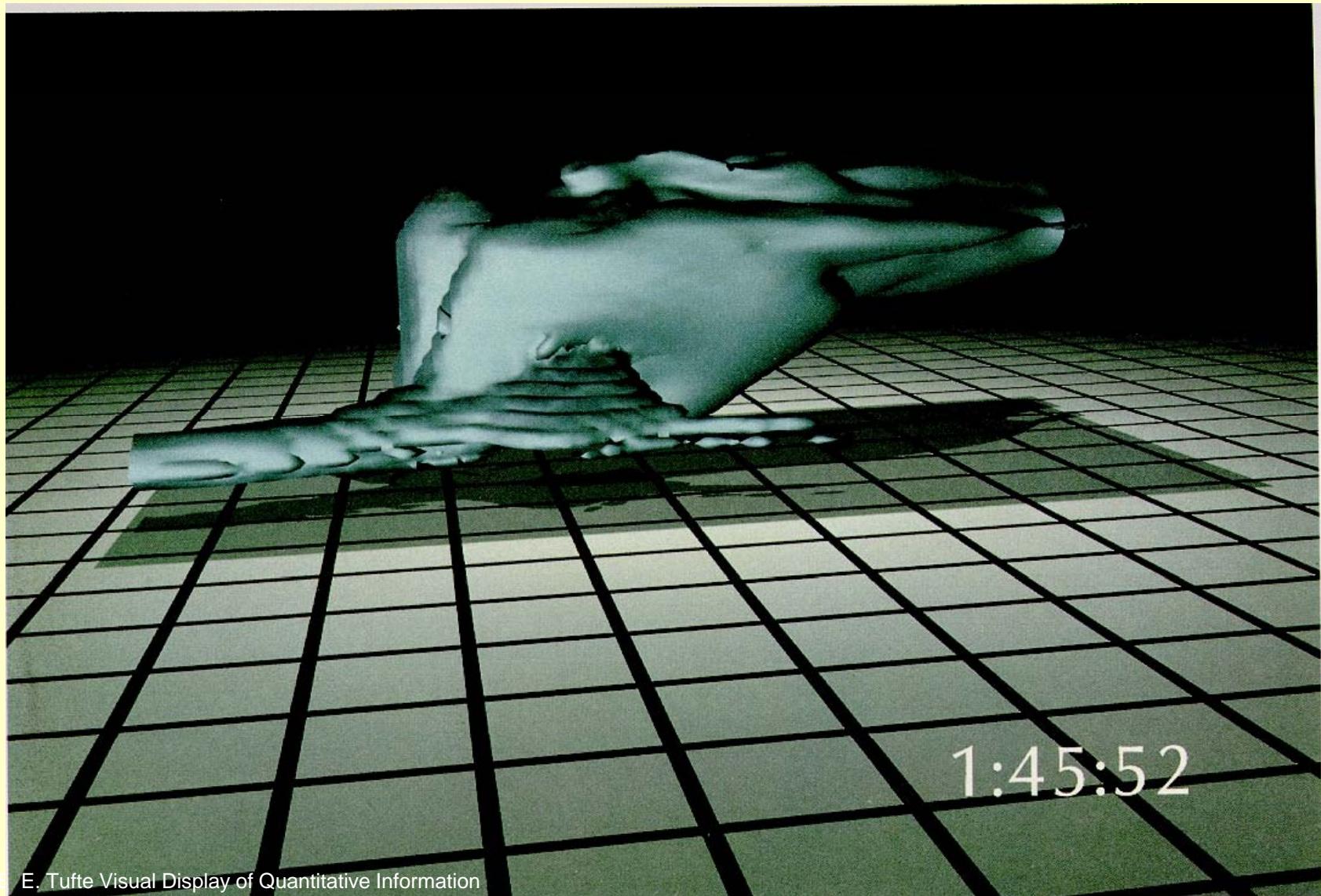


Small multiples

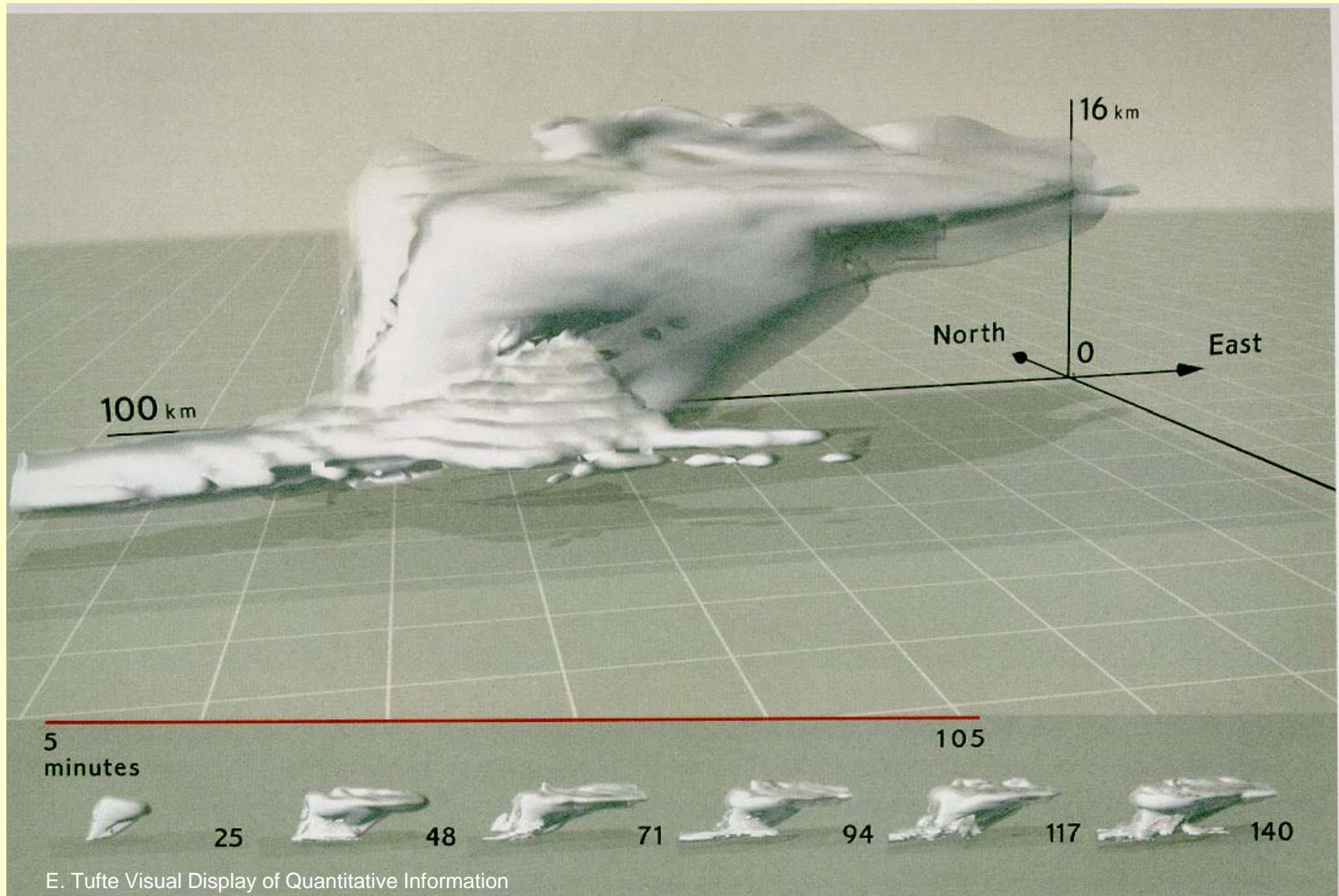
Learn once
– invite comparisons



Small multiples: Showing time and change



Small multiples: Showing time and change



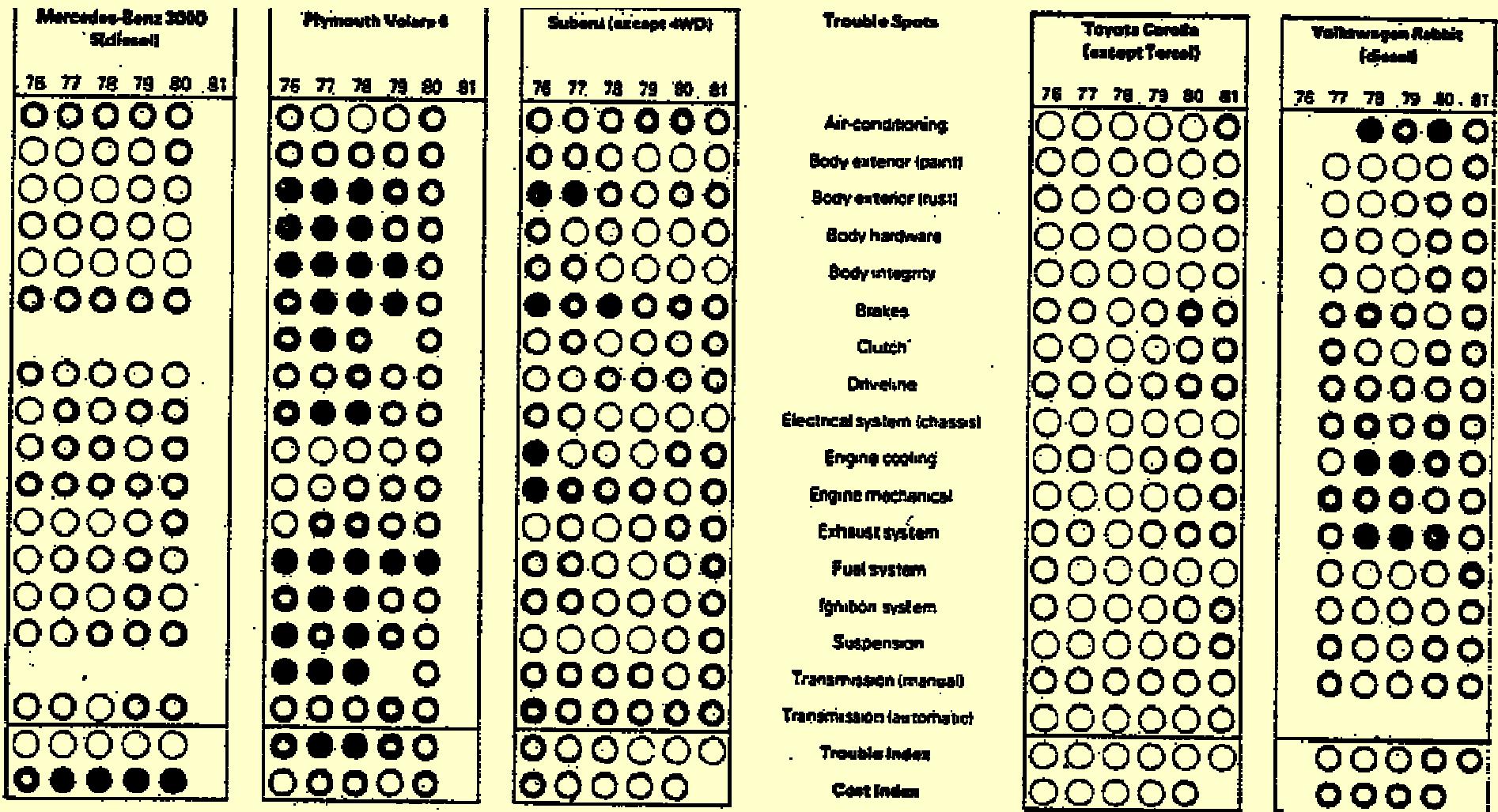
Visual information-seeking mantra

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

Shneiderman, Designing the User Interface 3rd Ed. 1997 p523

Overview & detail for comparisons

using small multiples and data density



PhotoFinder

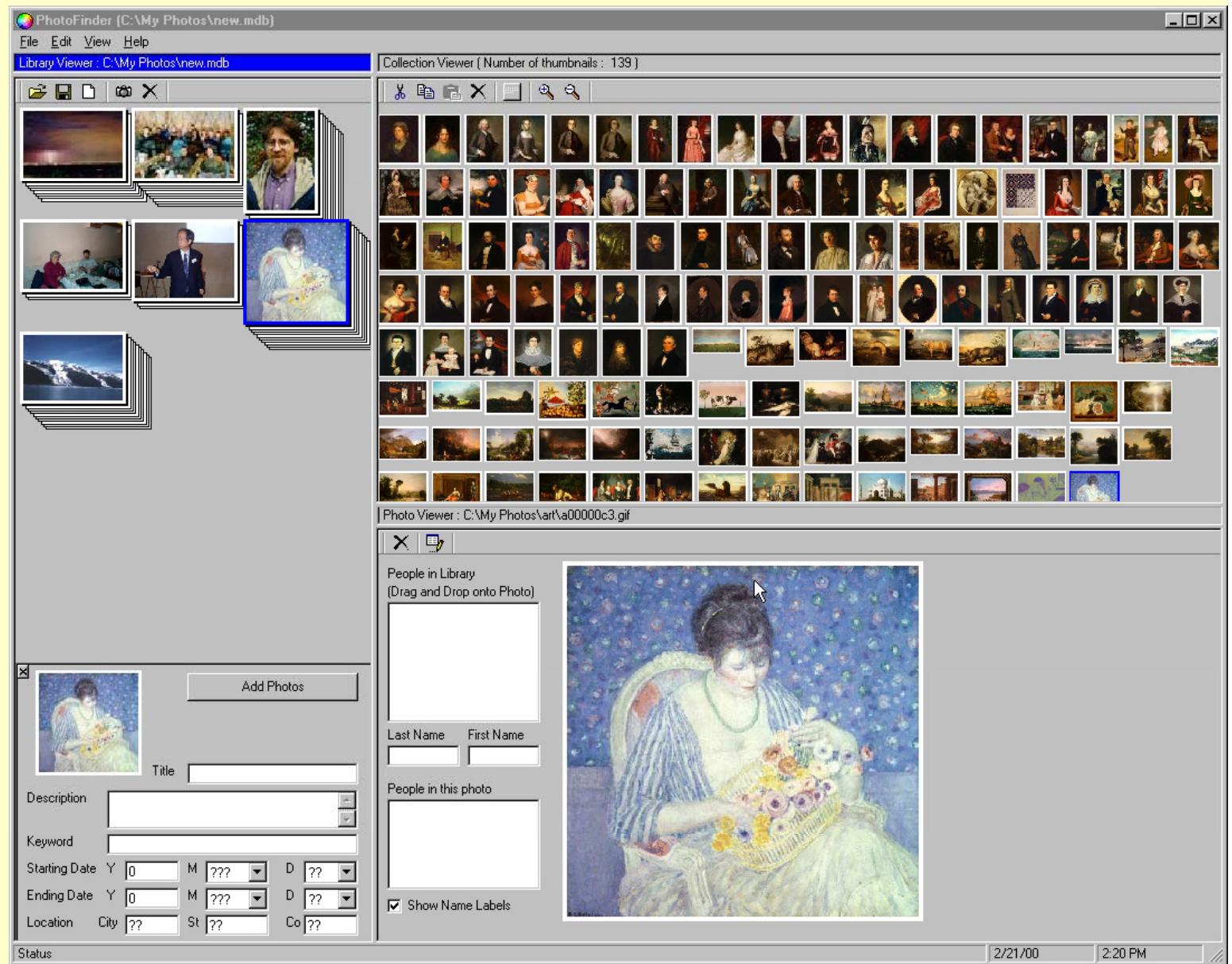


Table Lens

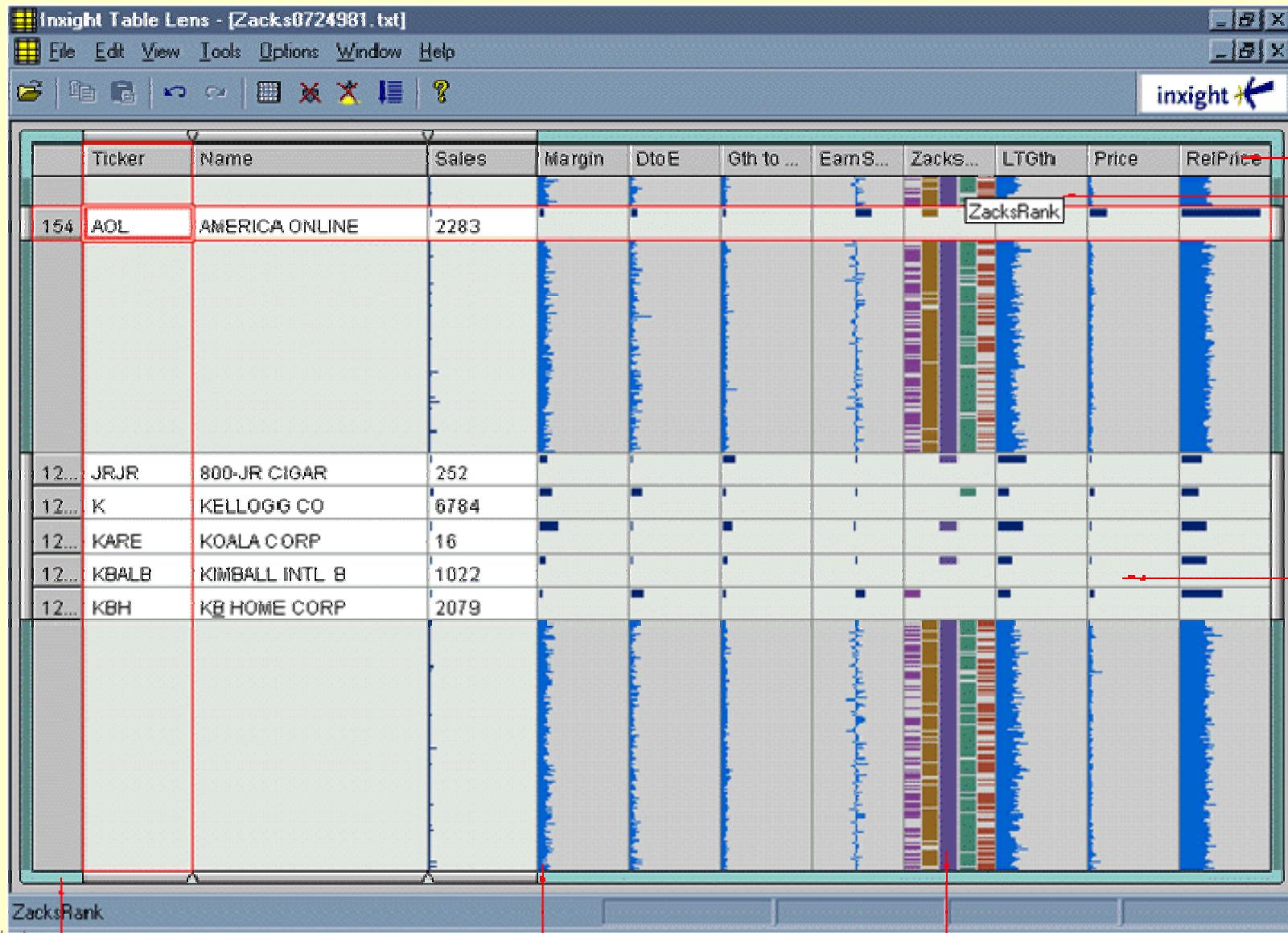


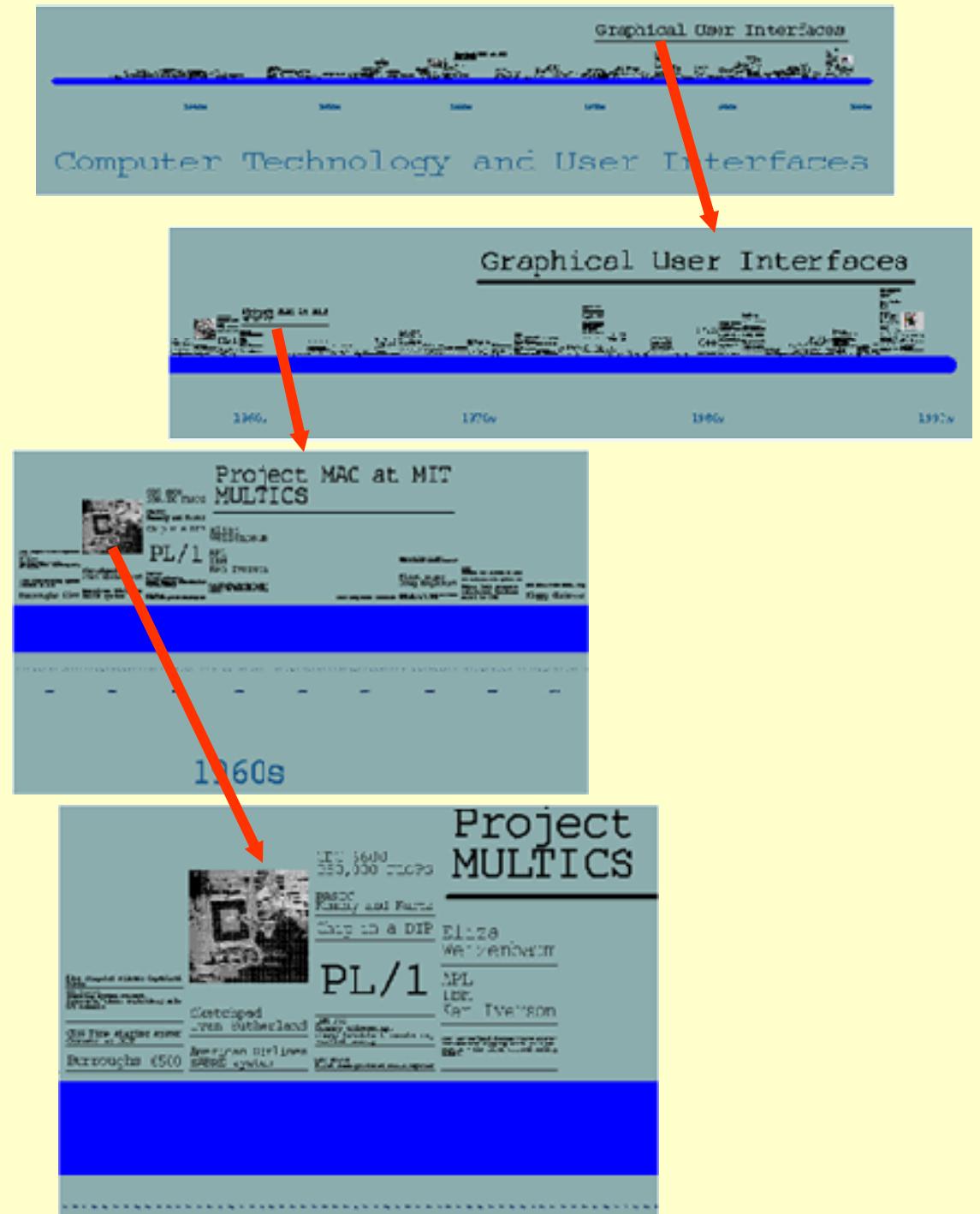
Table Lens

Housing Market for Santa Clara County, CA - March 2000

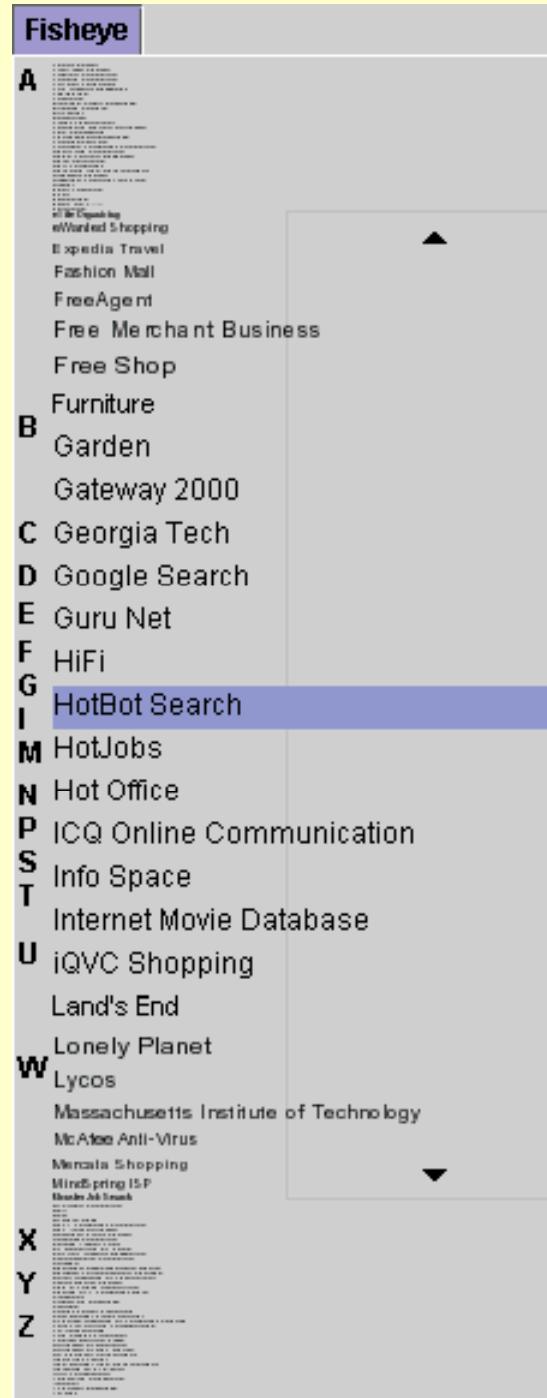
The screenshot shows a data visualization tool named "inxight" displaying a table of housing market data. The table has 12 columns: Bedrooms, Price, Square Foot, Status, Baths, Address, City, State, Zip, Realtor, and MLS #. The data is organized by number of bedrooms (5, 4, 3, 2) in the first column. The "Price" column is highlighted with a red border, labeled as the "Spotlight Column". The data rows show various properties with details like price (\$389,000), square footage (3531, 2281, -), status (Sale Pending), baths (4, 3, 1.5), address (6755 STEPH..., 3583 BAYO..., 1781 ANGEL...), city (Gilroy, San Jose, San Jose), state (CA), zip (95020, 95111, 95111), realtor (CENTURY 2..., BAY CITES ..., ROSE GARD...), and MLS # (4361, 10970, 944120).

Bedrooms	Price	Square Foot	Status	Baths	Address	City	State	Zip	Realtor	MLS #
5	151	389,000	3531	Sale Pending	4	6755 STEPH...	Gilroy	CA	95020	CENTURY 2... 4361
	152	389,000	2281		3	3583 BAYO...	San Jose	CA	95111	BAY CITES ... 10970
	153	389,000	-	Sale Pending	1.5	1781 ANGEL...	San Jose	CA	95111	ROSE GARD... 944120
	4									
3										
2										

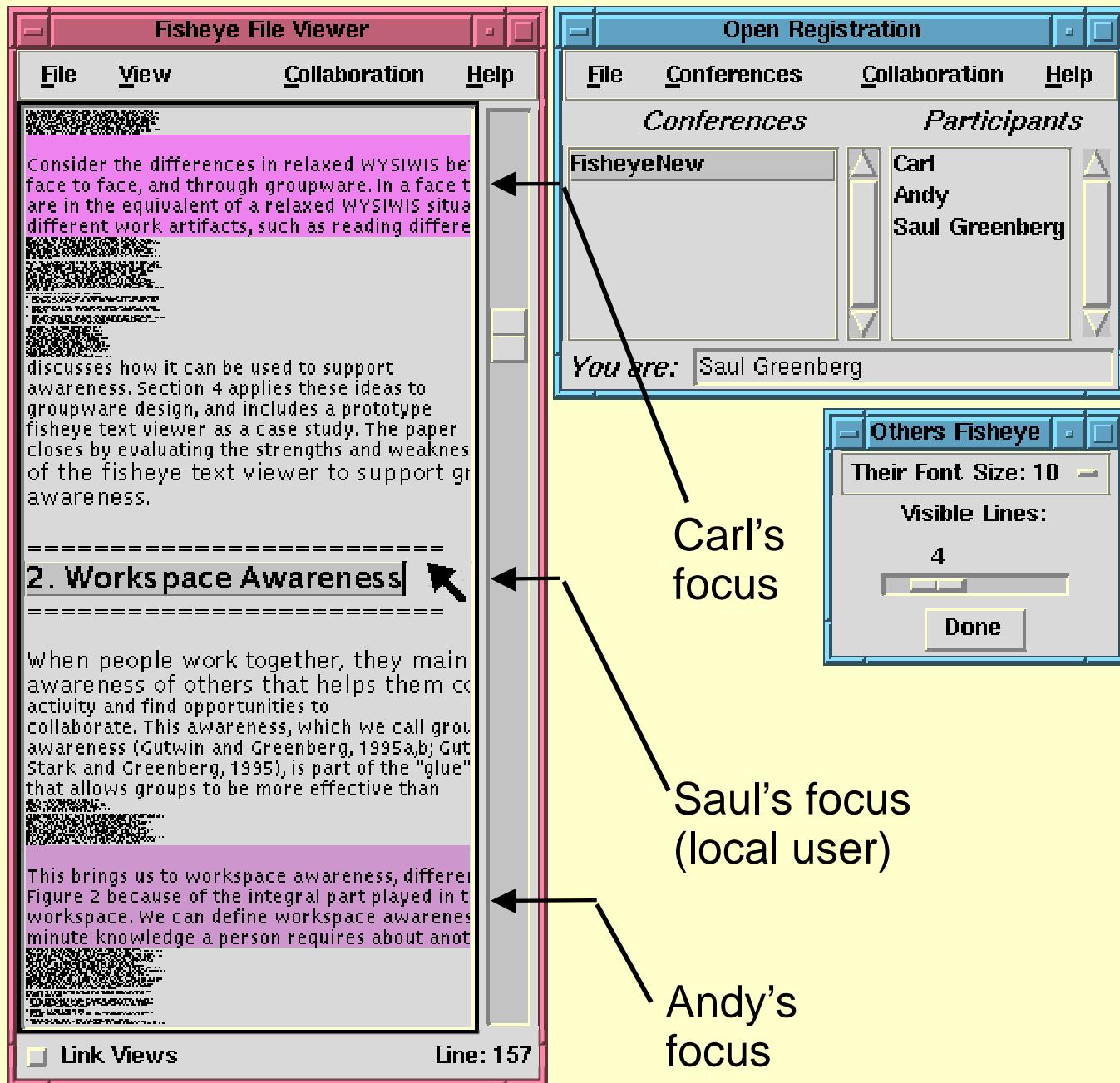
Infinite Zoom



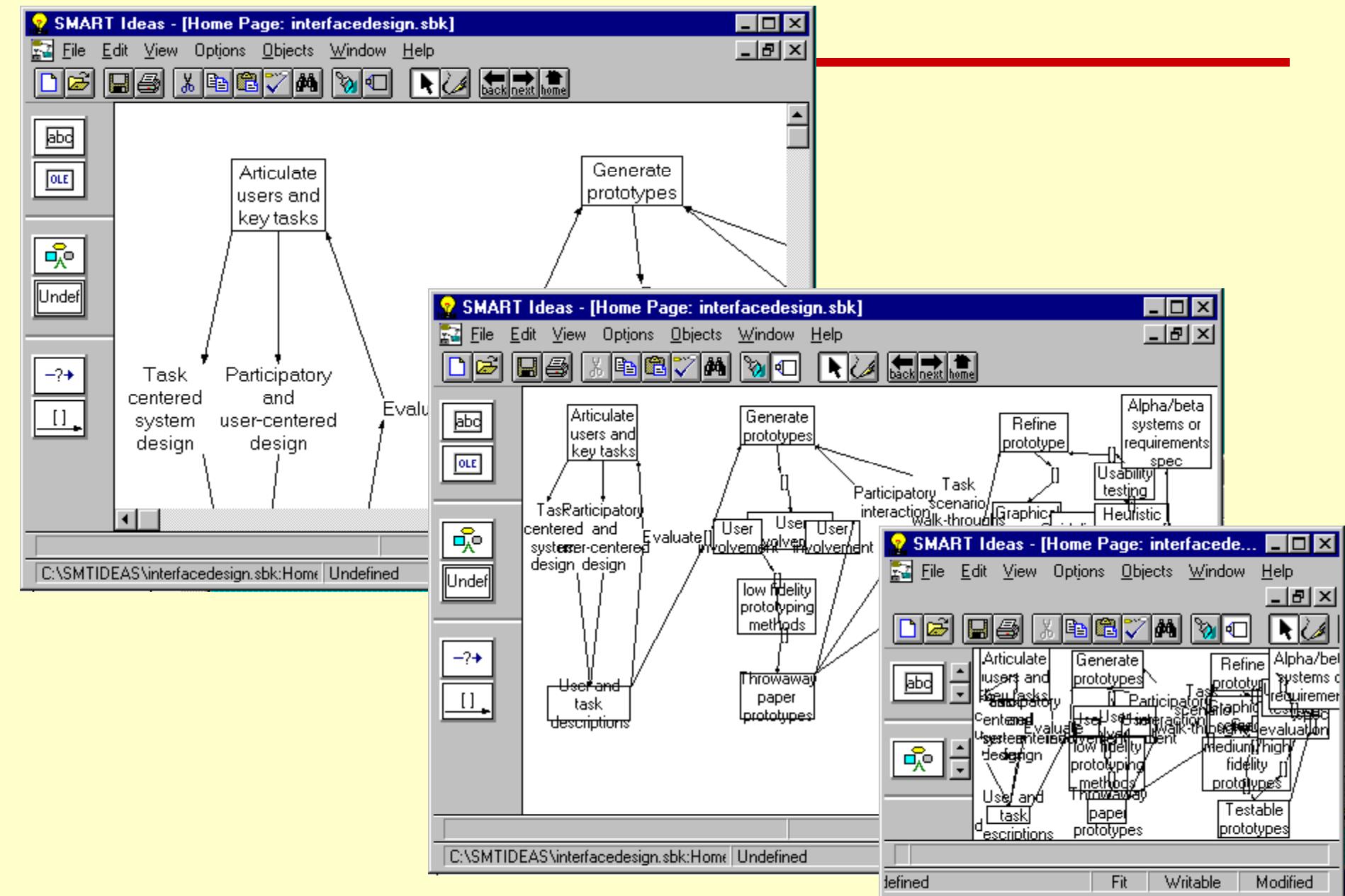
Fisheye Menus

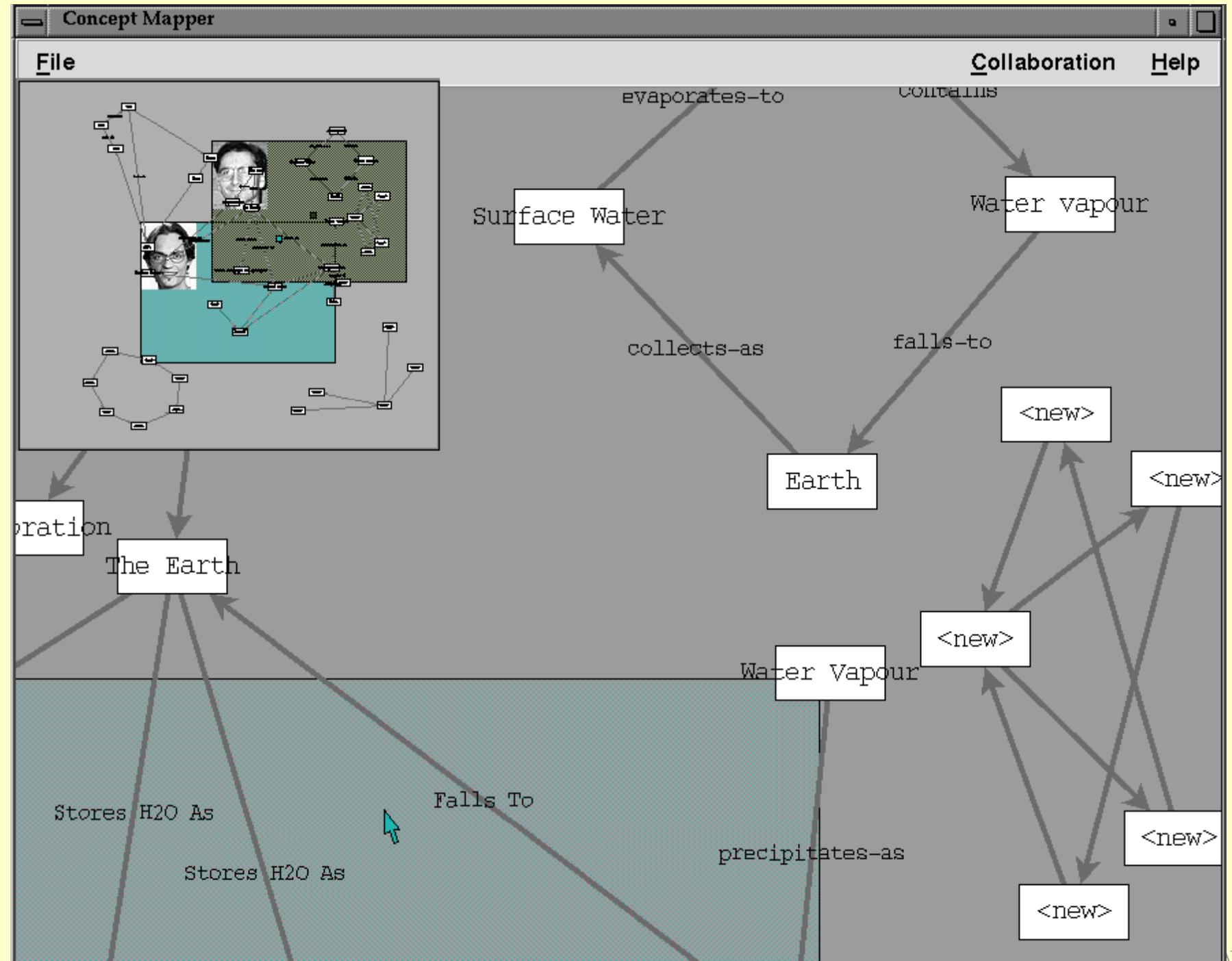


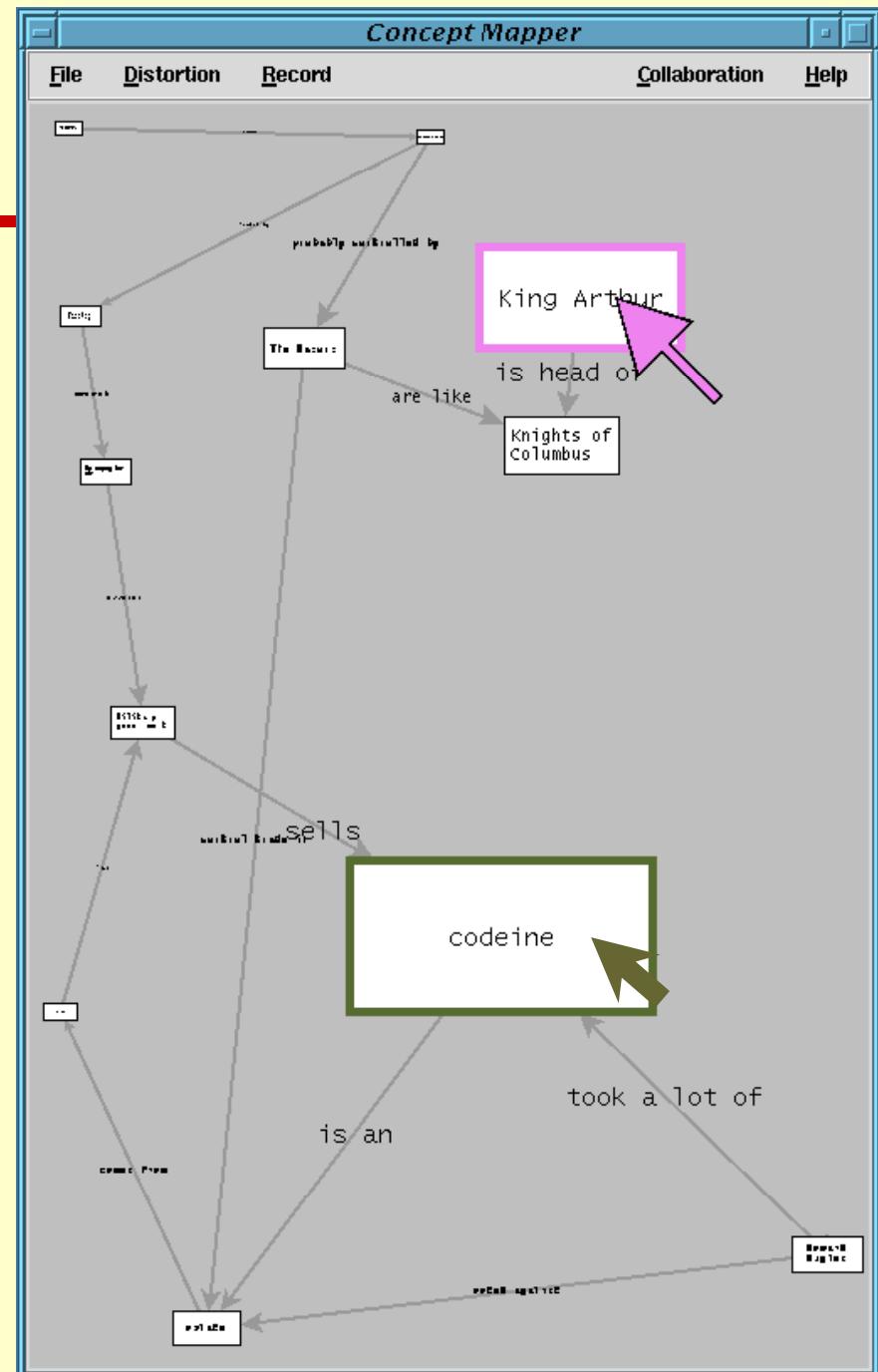
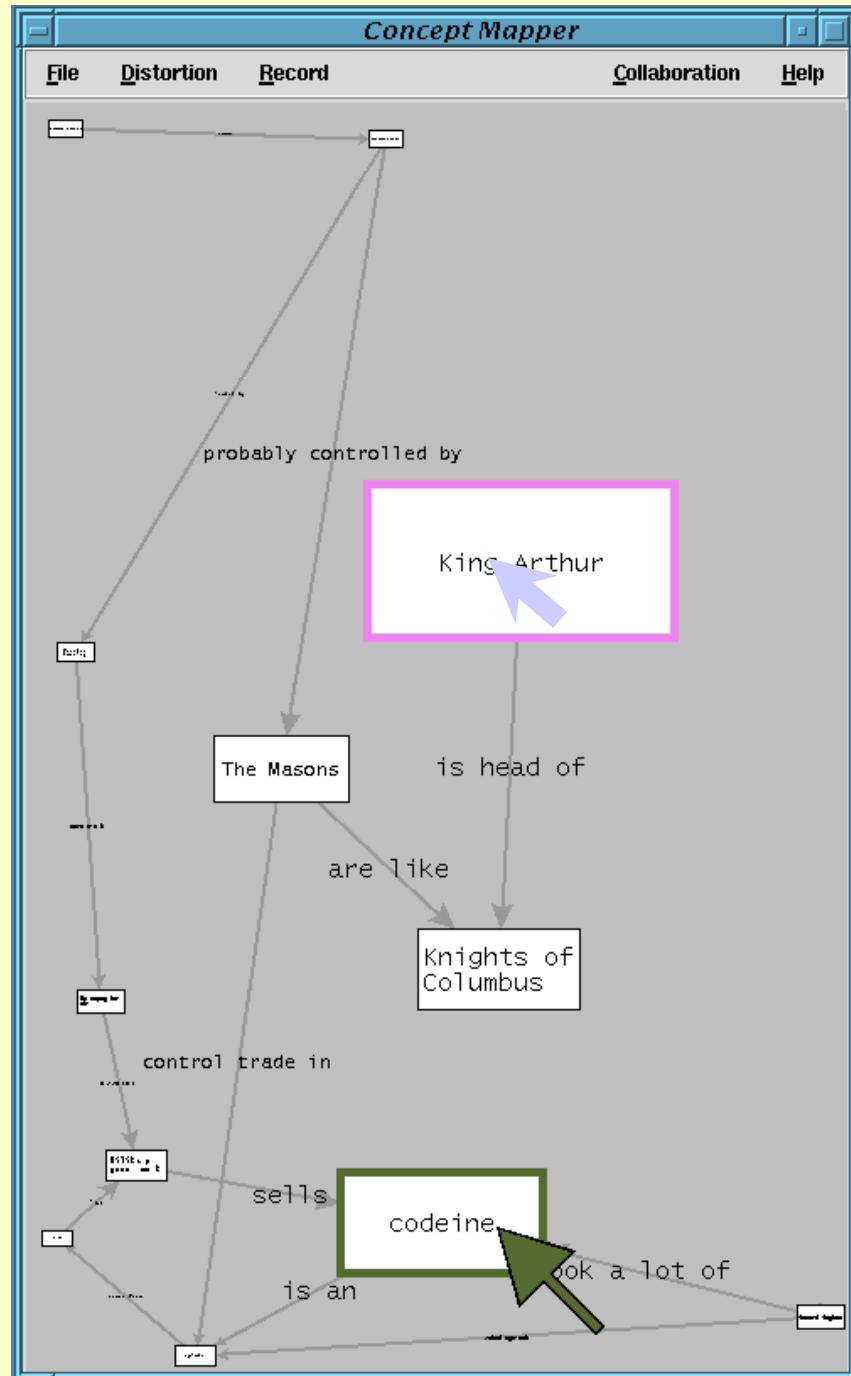
Fisheye Text *groupware*

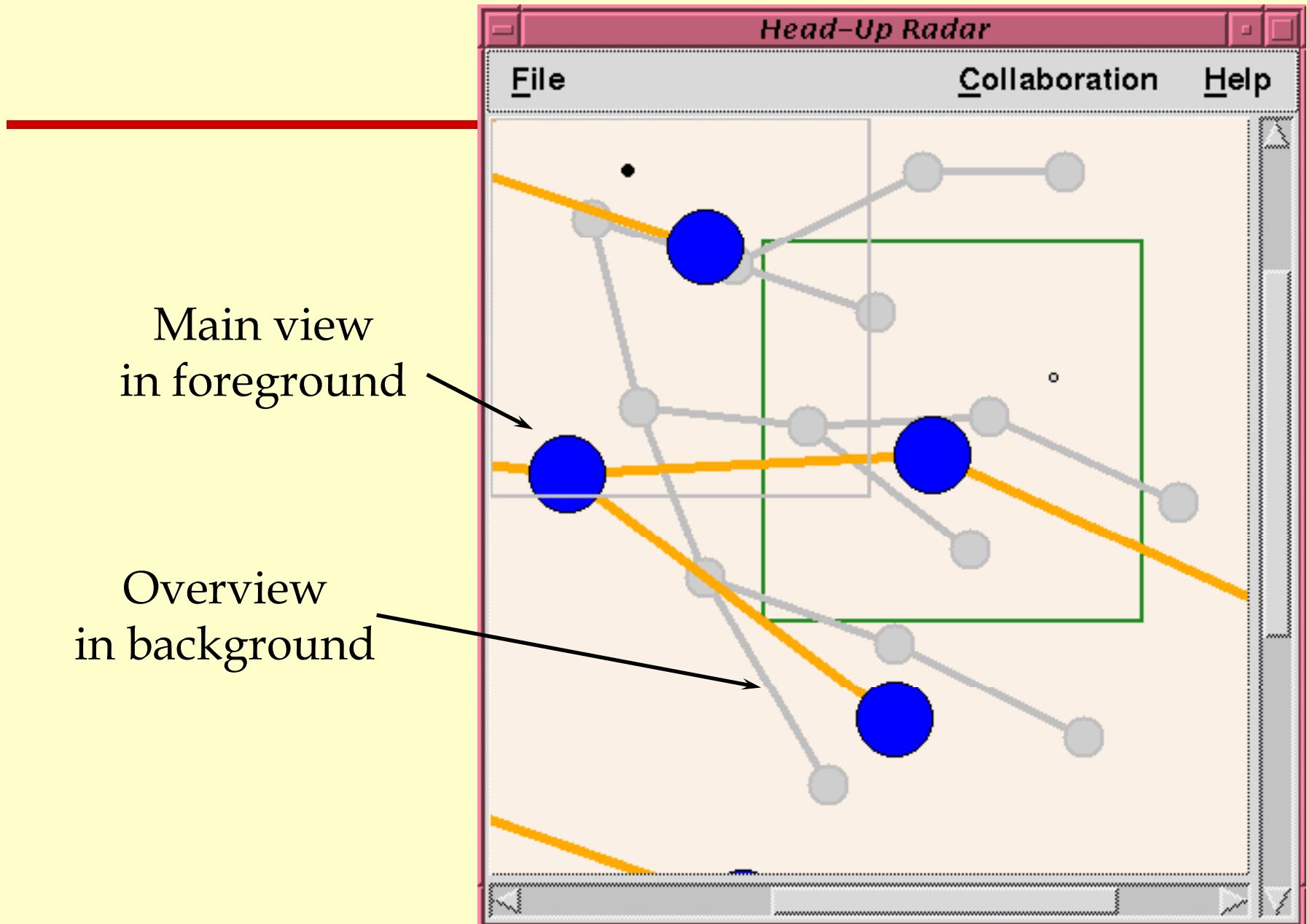


Case study: Concept mapping

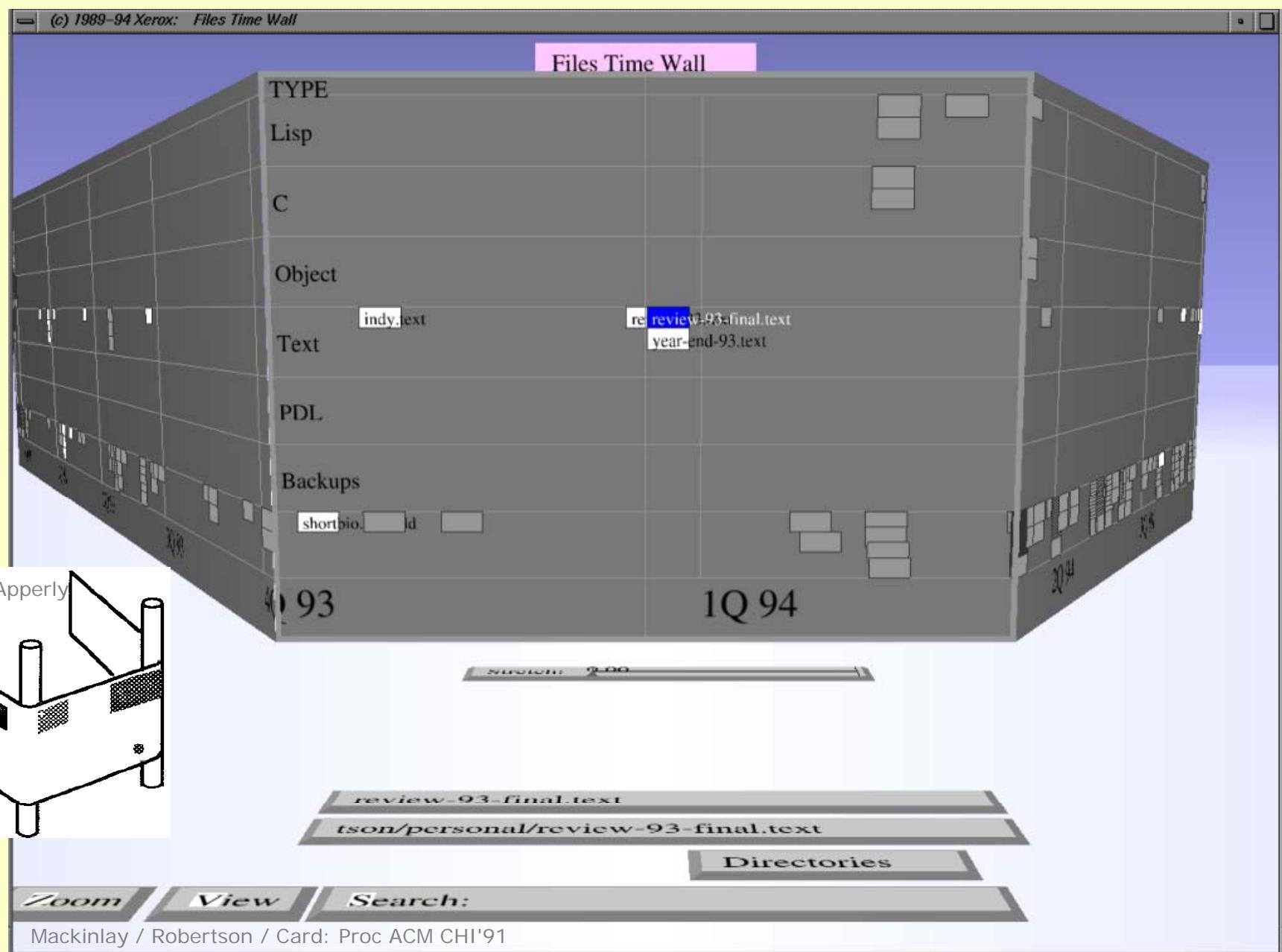




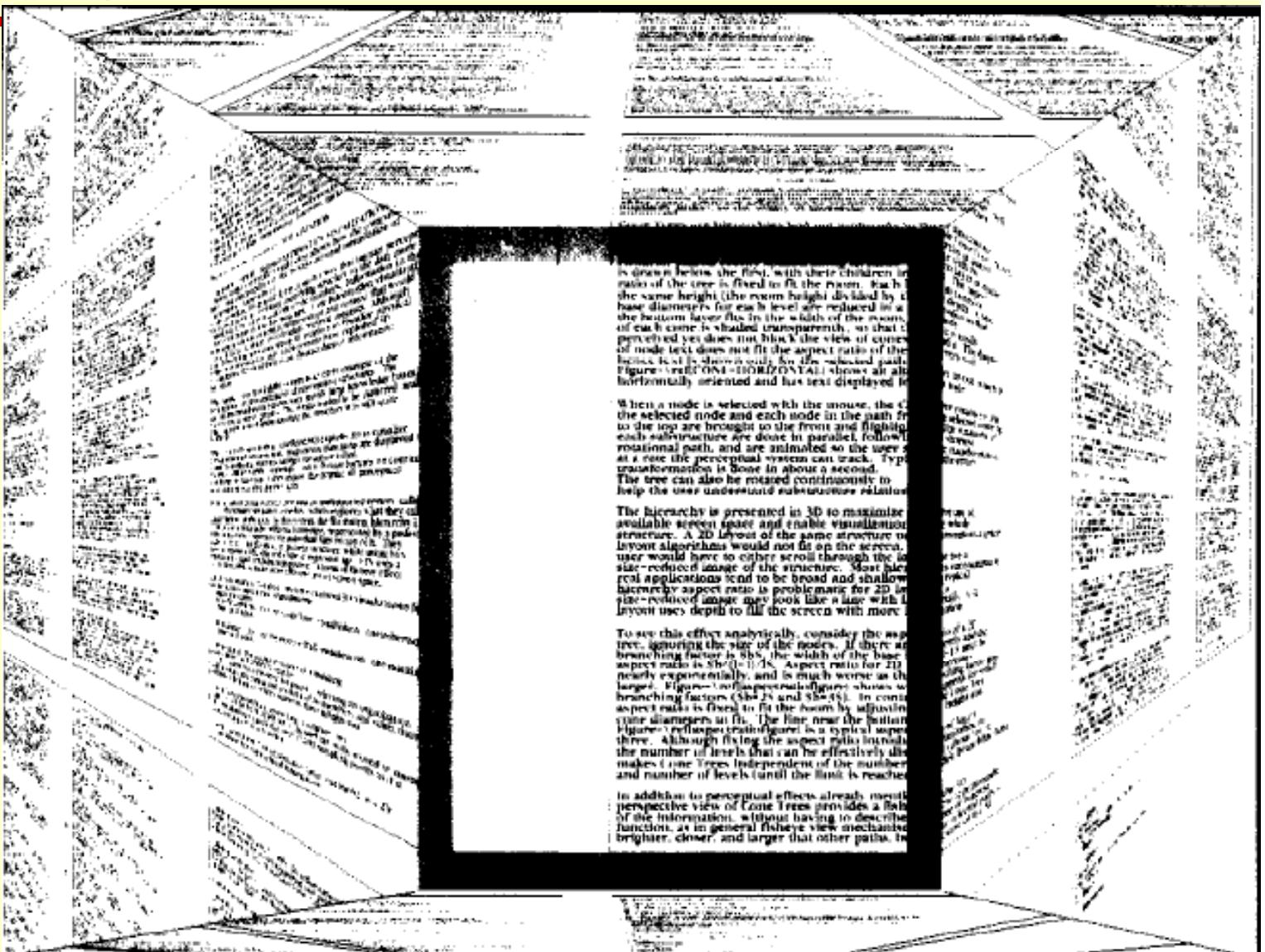




Perspective Wall



Document Lens



is drawn below the first, with their children in ratio of the tree is fixed to fit the room. Each the same height (the room height divided by a base diameter for each level are reduced in a base diameter for each level) are reduced in a bottom layer fits in the width of the room; of each cone is shaded transparently, so that it prevented yet does not block the view of cones made to fit the room. The next node is drawn in a new row. The user can click on any node in the tree to bring it to the front and flip it horizontally oriented and has text displayed in

When a node is selected with the mouse, the children of the selected node and each node in the path from the top are brought to the front and flipped. Each substructure is done in parallel, follow a rotational path, and are animated so the user sees at a rate the perceptual system can track. Typically transformation is done in about a second. The tree can also be rotated continuously to help the user understand substructure relations.

The hierarchy is presented in 3D to maximize available screen real estate and enable visualization of structure. A 2D layout of the same structure or layout algorithm would not fit on the screen. The user would have to either scroll through the full size-reduced image of the structure. Most other real applications tend to be broad and shallow. Hierarchy aspect ratio is problematic for 2D. In size-reduced image may look like a line with 3D layout uses depth to fill the screen with more

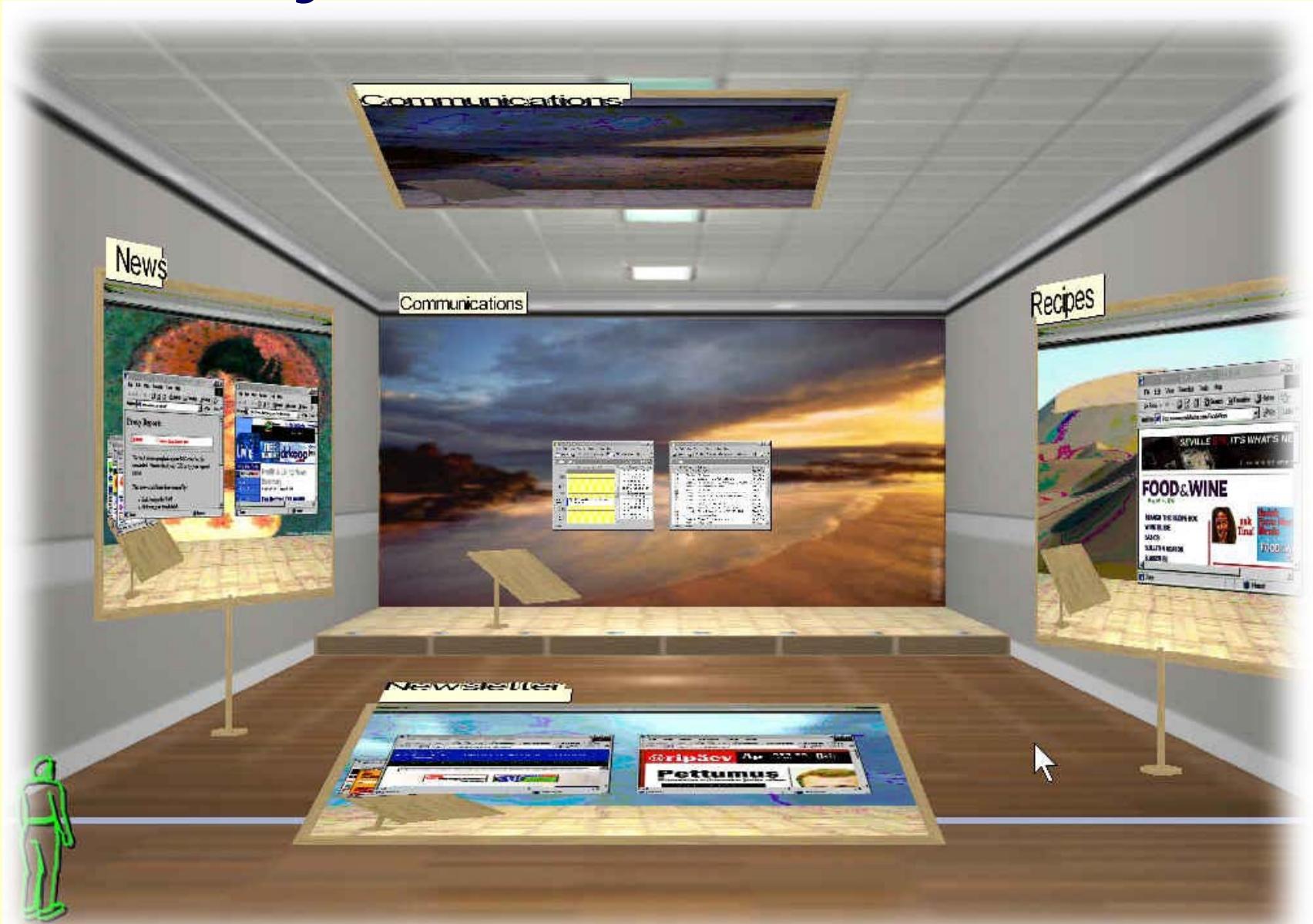
To see this effect analytically, consider the aspect ratio of a tree, ignoring the size of the nodes. If there are branching factor of 8/5, the width of the base aspect ratio is 8/5 (0.16). Aspect ratio for 2D layout is typically 1, and aspect ratio were as 1/2 (0.5). Figures 1 and 2 are typical figures based on branching factors of 8/5 and 8/5^{1/2}. In cones aspect ratio is fixed to fit the room by adjusting cone diameters as in fig. 1. The line near the bottom of figure 1 reflects aspect ratio is a typical aspect ratio. Although fixing the aspect ratio limits the number of levels that can be effectively displayed, it makes Cone Trees independent of the number and number of levels (until the limit is reached).

In addition to perceptual effects already mentioned, perspective view of Cone Trees provides a field of view of the information, without having to describe the function, as in general fisheye view mechanism. It makes Cone Trees brighter, closer, and larger than other paths. In

Data Mountain

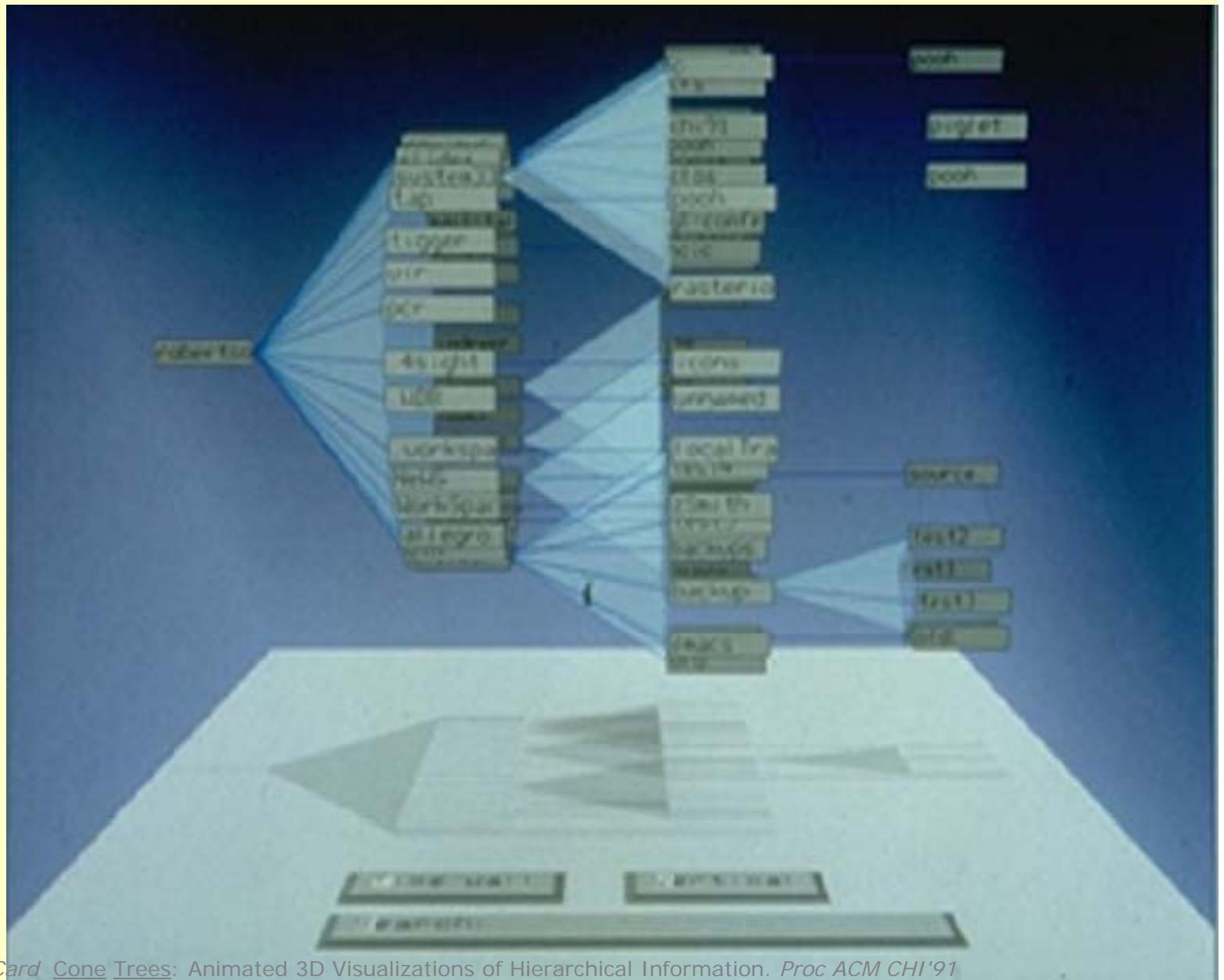


Task Gallery



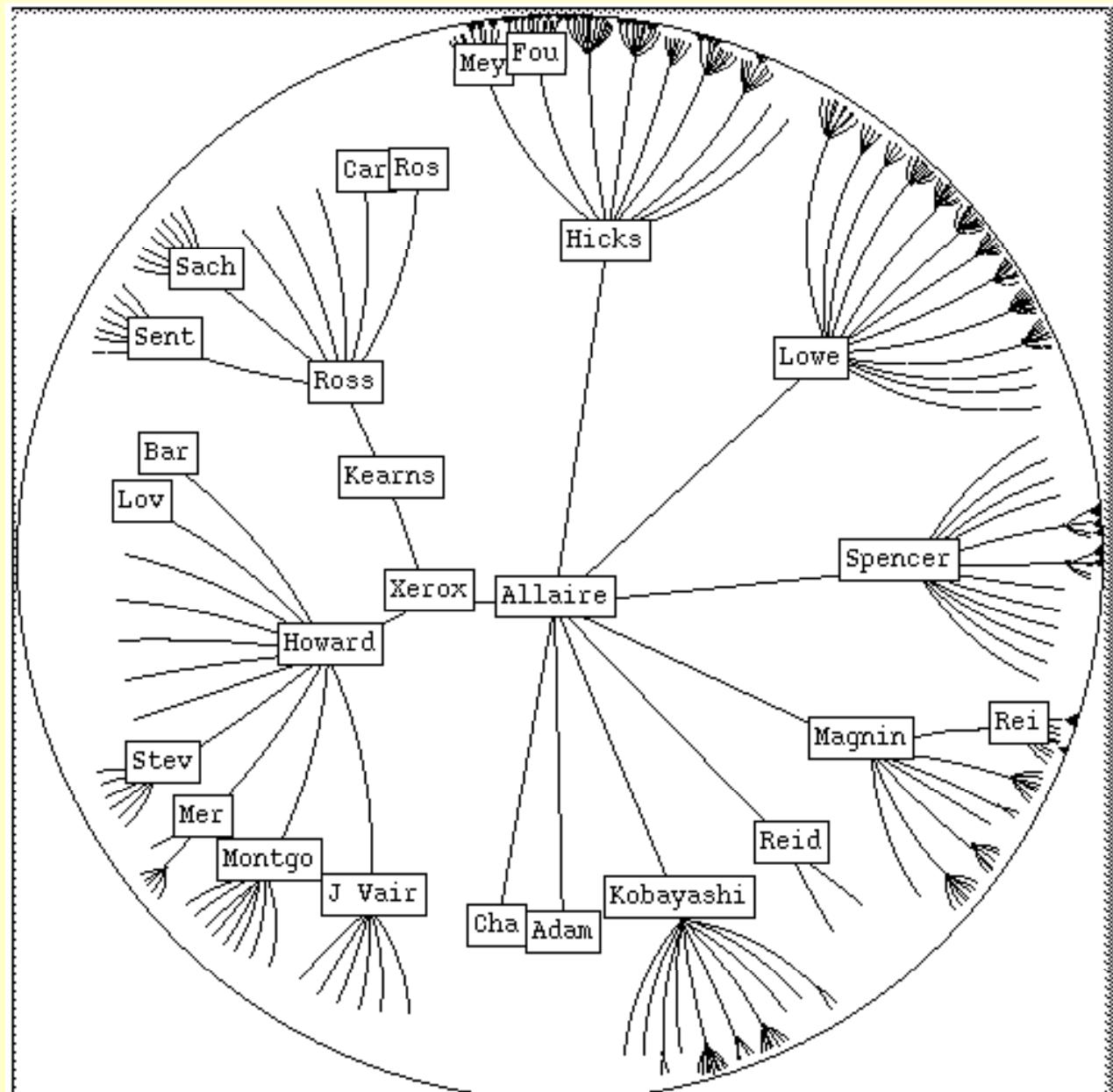
www.research.microsoft.com/ui/TaskGallery/

Cone Trees



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

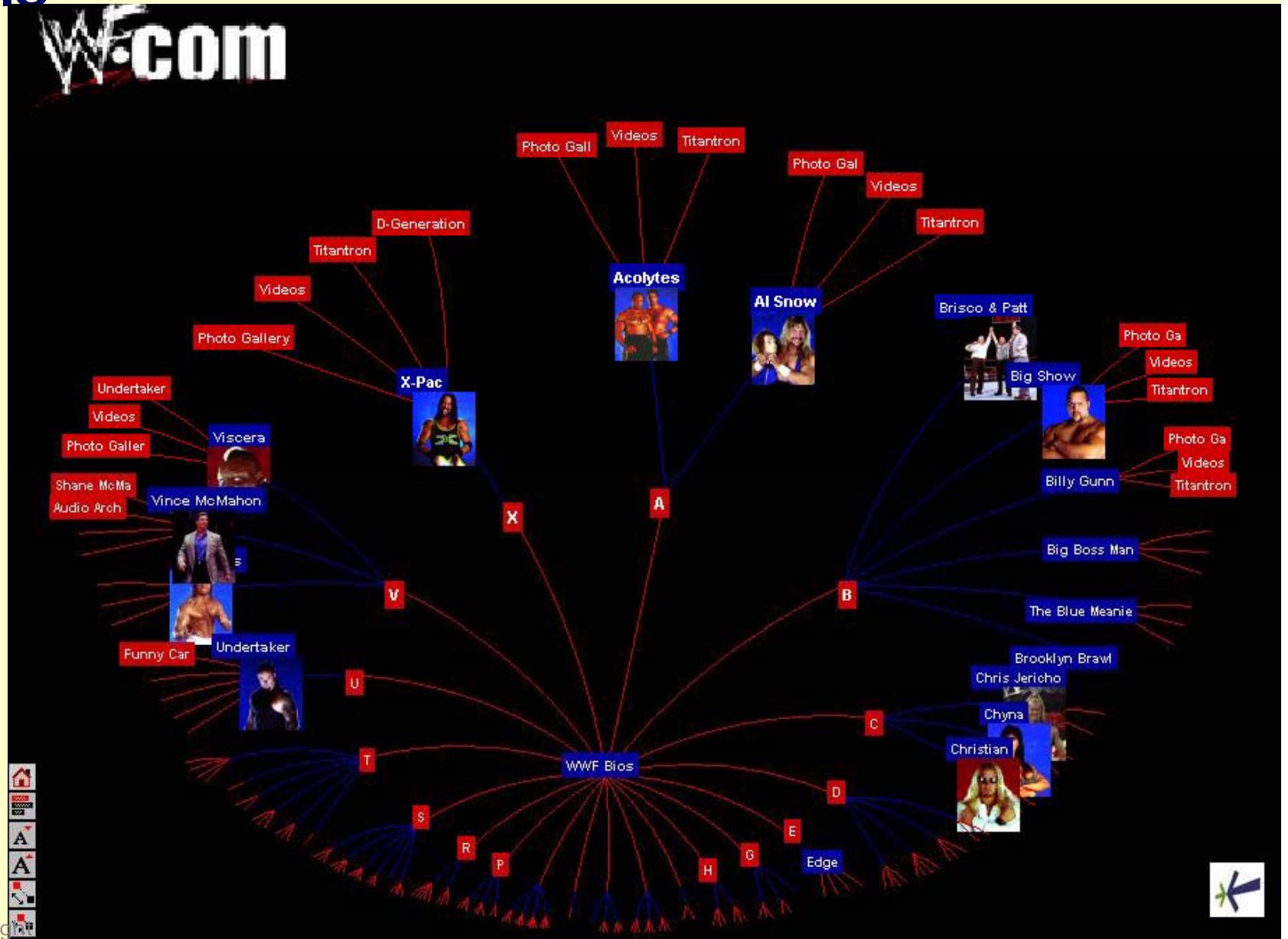
Hyperbolic Lens



P. A. Allaire, President, President

401 -- ???

Hyperbolic Lens



What you now know

Good representations

- captures essential elements of the event / world & mutes the irrelevant
- appropriate for the person, their task, and their interpretation

Information visualization

- Tufte's principles
- overview first, zoom and filter, then details on demand
- many techniques now available

Interface Design and Usability Engineering

