Information Visualization and Visual Communication

HCI, 12. 09. 2006.

Inspiration bits

http://www.youtube.com/v/RK_WLVO-TgA
http://www.youtube.com/v/PLhMVNdplJc
http://www.dagbladet.no/dinside/2006/06/24/469748.html

Information Visualization

visualize: to imagine or remember as if actually seeing.
American Heritage dictionary, Concise Oxford dictionary

Information visualization is a complex research area. It builds on information design, computer graphics, human-computer interaction and cognitive science.

Information visualization is the use of interactive, sensory representations, typically visual, of abstract data to reinforce cognition (from wikipedia).
Practical application of information visualization involves depiction of information using spatial or graphical representations, to facilitate comparison, pattern recognition, change detection, and other cognitive skills by making use of the visual system.

Orientation: visual problem solving and reasoning, communication

Information Visualization

- Problem:
  - HUGE Datasets: How to understand them?
- Solution
  - Take better advantage of human perceptual system
  - Convert information into a graphical representation.
- Issues
  - How to convert abstract information into graphical form?
  - Do visualizations do a better job than other methods?

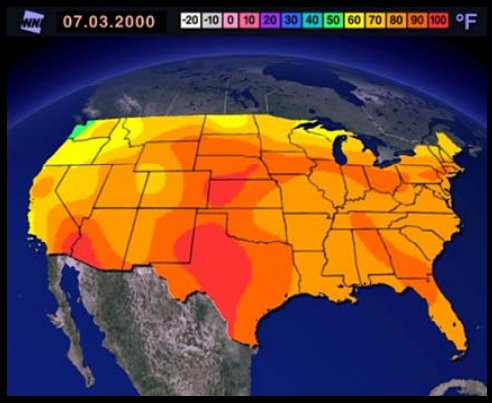
CHI 2003 tutorial on Information Visualization:
Principles, Promise, and Pragmatics
Marti Hearst (see web for more)

Wikipedia definition of visualization

- http://en.wikipedia.org/wiki/Visualization_%28graphic%29#Information_visualization

Browse, there are loads of interesting things to find out about!

Visualization Success Stories



Images from yahoo.com

Visualization Success Story

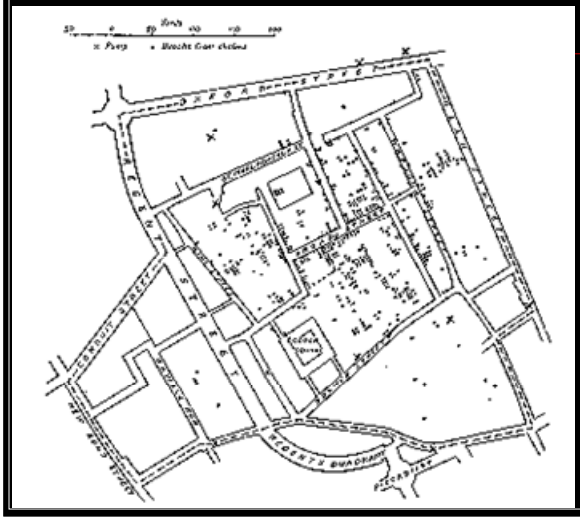


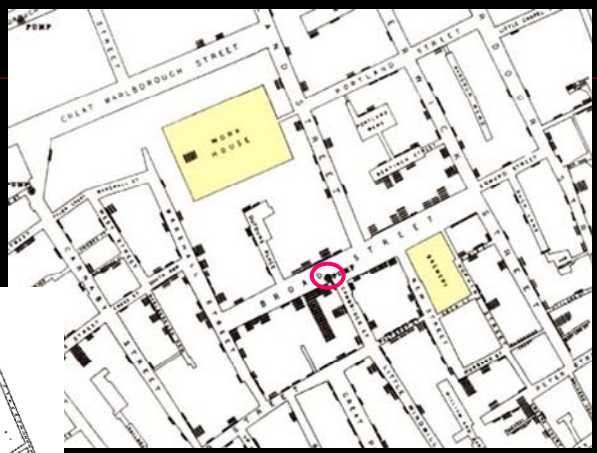
Illustration of John Snow's
deduction that a cholera epidemic
was caused by a bad water pump, circa 1854.

Horizontal lines indicate location of deaths.

From Visual Explanations by Edward Tufte, Graphics Press, 1997

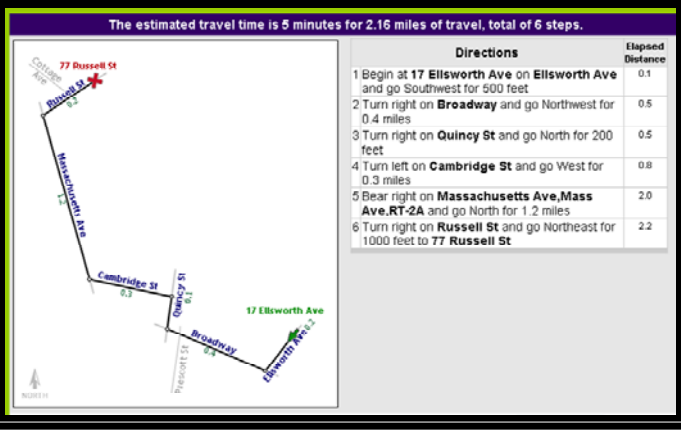
Visualization Success Story

Illustration of John Snow's deduction that a cholera epidemic was caused by a bad water pump, circa 1854.

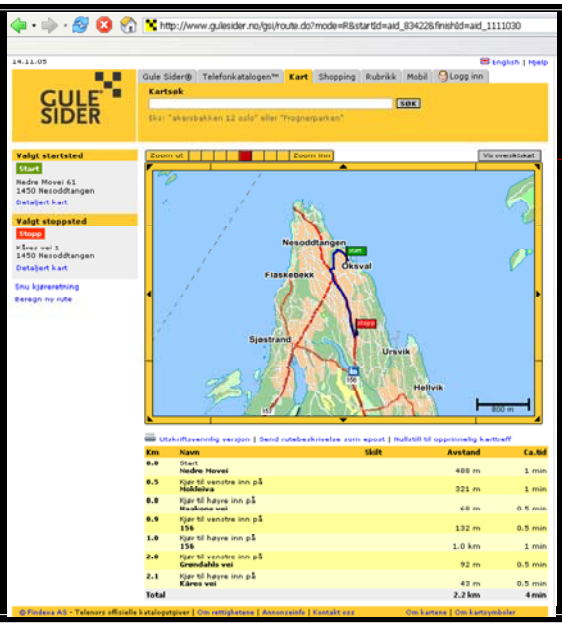


From Visual Explanations by Edward Tufte, Graphics Press, 1997

The Power of Visualization



Line drawing tool by Maneesh Agrawala http://graphics.stanford.edu/~maneesh/



Same purpose,
from Gule Sider

Which one do you think works better? Why?

Purposes of Information Visualization

To help:

- Explore
- Calculate
- Communicate
- Decorate

Two Different Primary Goals: Two Different Types of Viz

Explore/Calculate

- Analyze
- Reason about Information

Communicate

- Explain
- Make Decisions
- Reason about Information

Goals of Information Visualization

More specifically, visualization should:

- Make large datasets coherent
  - (Present huge amounts of information compactly)
- Present information from various viewpoints
- Present information at several levels of detail
  - (from overviews to fine structure)
- Support visual comparisons
- Tell stories about the data

Why Visualization?

Use the eye for pattern recognition; people are good at

- scanning
- recognizing
- remembering images

Graphical elements facilitate comparisons via

- length
- shape
- orientation
- texture

Animation shows changes across time

Color helps make distinctions

Aesthetics make the process appealing

A Key Question

How do we

Convert abstract information into a visual representation

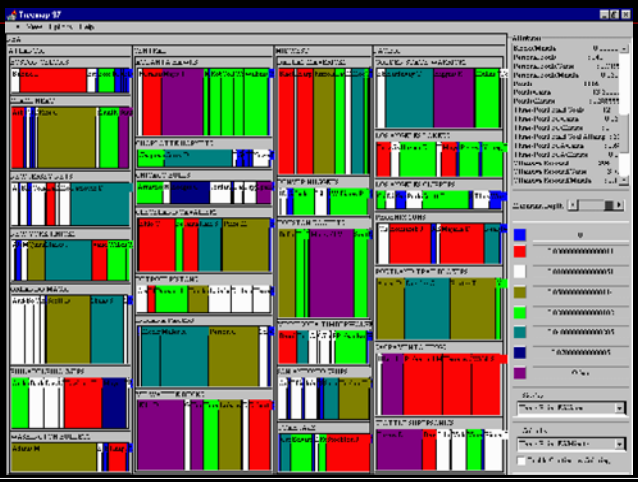
while still preserving the underlying meaning

and at the same time providing new insight?

Case Study: The Journey of the TreeMap

- The TreeMap **(Johnson & Shneiderman '91)**
- Idea:
  - Show a hierarchy as a 2D layout
  - Fill up the space with rectangles representing objects
  - Size on screen indicates relative size of underlying objects.

Early Treemap Applied to File System



Treemap Problems

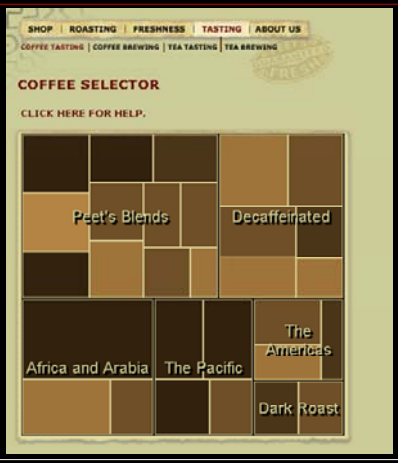
- Too disorderly
  - What does adjacency mean?
  - Aspect ratios uncontrolled leads to lots of skinny boxes that clutter
- Color not used appropriately
  - In fact, is meaningless here
- Wrong application
  - Don’t need all this to just see the largest files in the OS

Successful Application of Treemaps

- Think more about the use
  - Break into meaningful groups
  - Fix these into a useful aspect ratio
- Use visual properties properly
  - Use color to distinguish meaningfully
    - Use only two colors:
      - Can then distinguish one thing from another
    - When exact numbers aren't very important
- Provide excellent interactivity
  - Access to the real data
  - Makes it into a useful tool

A Good Use of Treemaps and Interactivity

Treemaps in Peets site



Analysis vs. Communication

- MarketMap's use of TreeMaps allows for sophisticated analysis
- Peets' use of TreeMaps is more for presentation and communication
- This is a key contrast

Key Questions to Ask about a Viz

1. What does it teach/show/elucidate?
2. What is the key contribution?
3. What are some compelling, *useful* examples?
4. Could it have been done more simply?
5. Have there been usability studies done? What do they show?

What we are *not* covering

- Scientific visualization
- Statistics
- Cartography (maps)
- Education
- Games
- Computer graphics in general
- Computational geometry

Visual Communication

We have seen a bit about what visualization is, how it can be used, why do we need it etc.

Now:

How do we “talk back” visually.

Visual intelligence

- Visual culture
- Visual perception
- Visual language
- Visual literacy
- Visual intelligence/multiple intelligences
- Design (interaction design)

Visual culture

Our culture is becoming increasingly visual.

We are bombarded by images in our daily lives: TV, papers, advertisement industry, entertainment industry, web, computer games, film, signage etc. These have an enormous impact on individual lives and on the society.

We are also attempting to use the directness of visual expression to capture the complexity and the quantity of information. (seeing is believing; one picture is worth 1000 words)

Visual Perception

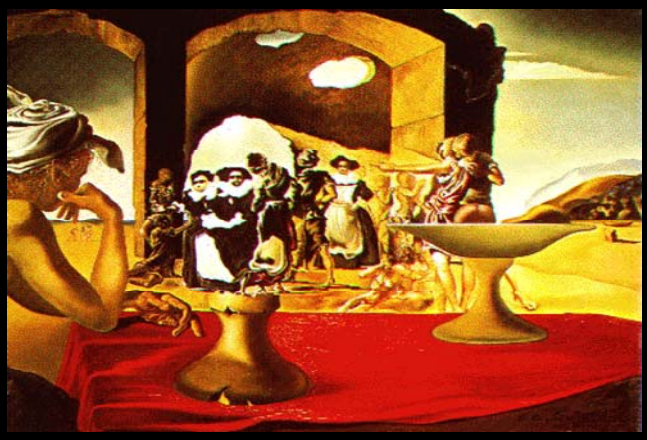
- behavioural model of visual perception and recognition
- Daniel Chandler's media course visual perception

The map is not the territory – Alfred Korzybsky

Human suffering originates from the confusion or conflation

of linguistic representations of reality and reality itself.

We believe what we see – perception is not reality Dali/Voltaire



Illusion

If you like illusions, you may go and play at

http://www.sandlotscience.com

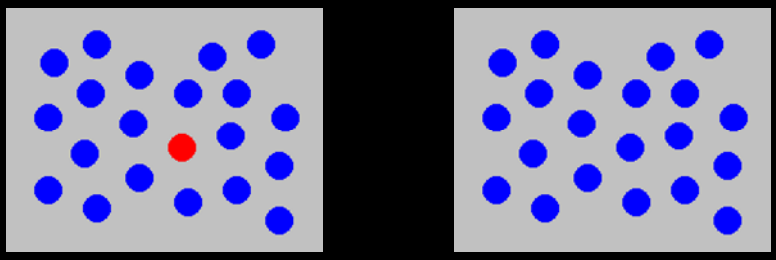
3D-vision

Properties of visual perception

- Preattentive Processing
- Accuracy of Interpretation of Visual Properties
- Illusions and the Relation to Graphical Integrity

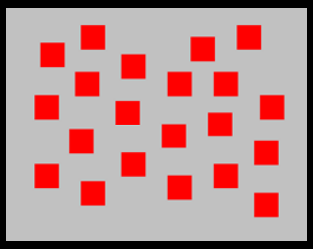
All Preattentive Processing figures from Healey 97
http://www.csc.ncsu.edu/faculty/healey/PP/PP.html

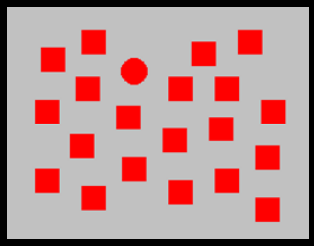
Example: Color Selection



Viewer can rapidly and accurately determine whether the target (red circle) is present or absent. Difference detected in color.

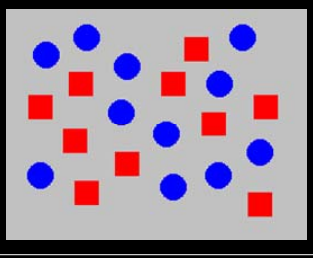
Example: Shape Selection

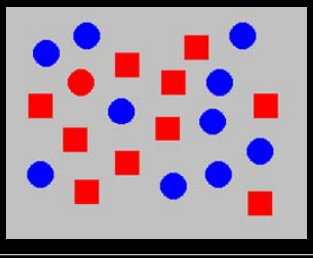




Viewer can rapidly and accurately determine whether the target (red circle) is present or absent. Difference detected in form (curvature)

Example: Conjunction of Features





Viewer *cannot* rapidly and accurately determine whether the target (red circle) is present or absent when target has two or more features, each of which are present in the distractors. Viewer must search sequentially.

All Preattentive Processing figures from Healey 97
http://www.csc.ncsu.edu/faculty/healey/PP/PP.html

Text NOT Preattentive

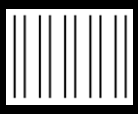
SUBJECT PUNCHED QUICKLY OXIDIZED TCEJBUS DEHCNUP YLKCIUQ DEZIDIXO
CERTAIN QUICKLY PUNCHED METHODS NIATREC YLKCIUQ DEHCNUP SDOHTEM
SCIENCE ENGLISH RECORDS COLUMNS ECNEICS HSILGNE SDROCER SNMULOC
GOVERNS PRECISE EXAMPLE MERCURY SNREVOG ESICERP ELPMAXE YRUCREM
CERTAIN QUICKLY PUNCHED METHODS NIATREC YLKCIUQ DEHCNUP SDOHTEM
GOVERNS PRECISE EXAMPLE MERCURY SNREVOG ESICERP ELPMAXE YRUCREM
SCIENCE ENGLISH RECORDS COLUMNS ECNEICS HSILGNE SDROCER SNMULOC
SUBJECT PUNCHED QUICKLY OXIDIZED TCEJBUS DEHCNUP YLKCIUQ DEZIDIXO
CERTAIN QUICKLY PUNCHED METHODS NIATREC YLKCIUQ DEHCNUP SDOHTEM
SCIENCE ENGLISH RECORDS COLUMNS ECNEICS HSILGNE SDROCER SNMULOC

Preattentive Visual Properties
(Healey 97)

length	Triesman & Gormican [1988]
width	Julesz [1985]
size	Triesman & Gelade [1980]
curvature	Triesman & Gormican [1988]
number	Julesz [1985]; Trick & Pylyshyn [1994]
terminators	Julesz & Bergen [1983]
intersection	Julesz & Bergen [1983]
closure	Enns [1986]; Triesman & Souther [1985]
colour (hue)	Nagy & Sanchez [1990, 1992]; D'Zmura [1991] Kawai et al. [1995]; Bauer et al. [1996]
intensity	Beck et al. [1983]; Triesman & Gormican [1988]
flicker	Julesz [1971]
direction of motion	Nakayama & Silverman [1986]; Driver & McLeod [1992]
binocular lustre	Wolfe & Franzel [1988]
stereoscopic depth	Nakayama & Silverman [1986]
3-D depth cues	Enns [1990]
lighting direction	Enns [1990]

Gestalt Properties

- *Gestalt:* form or configuration
- Idea: forms or patterns transcend the stimuli used to create them.
  - Why do patterns emerge?
  - Under what circumstances?



Which Properties are Appropriate for Which Information Types?

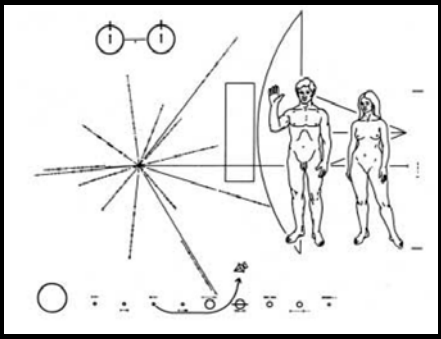
Exercise

Imagine that you are in a position to place an engraved plate on a space ship (just like it was done on Pioneer 10 and 11 in 1972 and 1973) in an attempt to communicate who we are as a species and where do we live in this Universe.

Take a minute for each of:

- what to say
- how to say it
- do it (produce visual representation of your idea)

How the exercise was solved



Note the difference
between the abstract
and the concrete representation