Visual Representation

Beyond Simple Screen Design
What are the characteristics of good representations?
What are the characteristics of good information visualization?
What role do metaphors play?
How can the use of direct manipulation help us?
**Representations (I)**

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?

![Image of buffalo]

- # Buffalo
- # Buffalo/kids
- # Adults
- # Kids

- 8
- 4

**Representations (II)**

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...

<table>
<thead>
<tr>
<th>Flight</th>
<th>Depart</th>
<th>Arrive</th>
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<tbody>
<tr>
<td>AC 117 Vancouver - Calgary</td>
<td>7:00</td>
<td>9:00</td>
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<tr>
<td>Cdn 321 Vancouver - Calgary</td>
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<tr>
<td>Cdn 355 Calgary - Montreal</td>
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<td>AC 123 Calgary - Toronto</td>
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<td>AC 123 Toronto - Montreal</td>
<td>16:45</td>
<td>17:30</td>
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</table>

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

When do I take my drugs?

Note: 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     O     O     O
Inderal    O     O     O     O
Quinag     O     O     O     O
Carafate   O     O     O     O
Zantac     O     O
Couma      O

Organized by both time of day and by drug
Which representation is best?

- Depends heavily on task

Want to know the precise value?

Want to know how the performance is now compared to its peak?

Want to know how performance change over time?

Where am I?

- Detailed navigation plus precision

- General navigation plus orientation
Where am I?

http://acg.media.mit.edu/people/fry/zipdecode/
Which folder has the most documents?

Which folder has the most photos?
What do I have to do?

What stock is doing best?

http://www.smartmoney.com/marketmap/
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

Note: many visual examples on the following slides are taken from Tufte’s books such as Visual Display of Quantitative Information

Anscombe’s Quartet

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<th>x4</th>
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<td>27.5</td>
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<td>13.8</td>
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<td>0.8</td>
<td>0.8</td>
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<td>r squared:</td>
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<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
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<tr>
<td>regression line:</td>
<td>Y=3+0.5X</td>
<td>Y=3+0.5X</td>
<td>Y=3+0.5X</td>
<td>Y=3+0.5X</td>
</tr>
</tbody>
</table>

Graphics Reveal the Data
Deaths by Cholera
Dr John Snow 1854

Telling a story: Napoleon’s march to Moscow
by Charles Minard (1885)

Six Variables Shown:

Not Shown but COULD have been: Mood of the troops with shading? Others? How?
Data Density
New York Weather History
• 181 numbers/sq inch

Small Multiples
Learn once
Invite comparisons
Small multiples, data density, overview & detail, comparisons

Small Multiples: Showing Time and Change (I)
Data Ink & 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: Removing deception and simplification

Showing the Right Data: Challenger
Interaction

If a picture is worth a thousand words, then an interactive visualization is worth a thousand pictures.....

Metaphors (I)

Pervade excellent interfaces

<table>
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<th>B</th>
<th>C</th>
<th>D</th>
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<td>28</td>
<td>303.0</td>
<td>83.130</td>
<td>141.700</td>
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</tbody>
</table>

spreadsheet (actuary sheet)

games (literal world)
Metaphors (II)

Control Panels with familiar controls

Forms

Hierarchical Folders

Metaphors (III)

Definition of Metaphor
- application of name or descriptive term to an object to which it is not literally applicable

Purpose
- function as natural models
- leverages our knowledge of familiar, concrete objects/experiences to understand abstract computer and task concepts

Problem
- metaphor may portray inaccurate or naive conceptual model of the system

A presentation tool is like a slide projector
**Metaphors (IV)**

**Generating metaphors**

- Use metaphors that matches user’s conceptual task
  - desktop metaphor for office workers
  - paintbrush metaphor for artists...

- Given a choice, choose the metaphor close to the way the system works

- Ensure emotional tone is appropriate to users
  - eg file deletion metaphors
    - trashcan
    - black hole
    - paper shredder
    - pit bull terrier
    - nuclear disposal unit...

**Metaphors (V)**

**Evaluating metaphors**

- consider probable consequences
  - will metaphor restrict what people could actually do?
    - eg strict file/folder hierarchy vs system allows links between directories
  - will metaphor believe that people can do more than what is possible?
    - eg agent-based systems, Eliza...

**Evolve metaphors**

- is metaphor extensible to new features?
- when is the metaphor no longer useful?
**Metaphors (VI)**

Caveat
- metaphors can be overdone!

Common pitfalls
- overly literal
  - unnecessary fidelity
  - excessive interactions
- overly cute
  - novelty quickly wears off
- overly restrictive
  - cannot move beyond
- mismatched
  - does not match user’s task and/or thinking

**Direct Engagement & Direct Manipulation**

Direct Engagement
- the feeling of working directly on the task

Direct Manipulation
- An interface that behaves as though the interaction was with a real-world object rather than with an abstract system

Central ideas
- visibility of the objects of interest
- rapid, reversible, incremental actions
- manipulation by pointing and moving
- immediate and continuous display of results

Almost always based on a metaphor
- mapped onto some facet of the real world task semantics)
Direct Engagement

Xerox Star: pioneered in late 70’s and early ’80s
= copied by almost everyone=

- simulates desktop with icons
  - in and out baskets
  - file folders and documents
  - calculators
  - printers
  - blank forms for letters and memos

- small number of generic actions applicable system wide
  - move, copy, delete, show properties, again, undo, help
    - eg same way to move text, documents, etc
  - property sheets
    - pop-up form, alterable by user

- What you see is what you get (WYSIWYG)

Xerox Star continued

Star’s observers:
- objects understood in terms of their visual characteristics
  - affordances, constraints
- actions understood in terms of their effects on the screen
  - causality
- intuitively reasonable actions can be performed at any time
  - conceptual model

A subtle thing happens when everything is visible:
the display becomes reality
**Object-Action**

Select object, then do action
- interface emphasizes 'nouns' (visible objects) rather than 'verbs' (actions)

Advantages
- closer to real world
- modeless interaction
- *actions* always within context of object
  - inappropriate ones can be hidden
- *generic commands*
  - the same type of action can be performed on the object
  - eg drag 'n drop:
    - folders
    - files
    - paragraphs
    - text
    - numbers...

**Action-Object**

Select action, then, pick object
- interface emphasizes 'verbs' (actions) rather than 'nouns' (visible objects)

Advantages
- Pick a setting and reuse it
- Often more efficient
Is direct manipulation the way to go?

Some Disadvantages

- Ill-suited for abstract operations
  - spell-checker?

- Tedium
  - manually search large database vs query

- Task domain may not have adequate physical/visual metaphor

- Metaphor may be overly-restrictive

Solution

- Most systems combine direct manipulation and abstractions
  - word processor:
    - WYSIWYG document (direct manipulation)
    - buttons, menus, dialog boxes (abstractions, but direct manipulation “in the small”)

Conventional Applications: A Mix
**What You Now Know**

**Good Representations**
- captures essential elements of the event / world
- deliberately leaves out / mutes the irrelevant
- appropriate for the person, their task, and their interpretation

**Metaphors**
- uses our knowledge of the familiar and concrete to represent abstract concepts
- need not be literal
- has limitations that must be understood

**Direct manipulation**
- visibility of the objects of interest
- rapid, reversible, incremental actions
- manipulation by pointing and moving
- immediate and continuous display of results

*These three components are the foundation of a true Visual Interface*