Information Representation

The Value of Data Visualization

http://vimeo.com/29684853
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?

Good information visualization...
...supports making discoveries.
...supports making decisions.
...supports discovering patterns.
...supports finding relevant information.
...capture essential elements of events.
...deliberately leaves out (or at least mutes) irrelevant data.
...is appropriate to the person viewing the data.
...is appropriate to the task being performed.

With good visualizations people can see trends, clusters, gaps, and outliers.
Use of colors, sizes, shapes, and locations all help with this.
How to represent quantity?

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...

<table>
<thead>
<tr>
<th>Flight</th>
<th>Depart</th>
<th>Arrive</th>
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</thead>
<tbody>
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<td>AC 117</td>
<td>7:00 Vancouver - Calgary</td>
<td>9:00</td>
</tr>
<tr>
<td>Cdn 32</td>
<td>9:00 Vancouver - Calgary</td>
<td>12:00</td>
</tr>
<tr>
<td>Cdn 35</td>
<td>13:30 Calgary - Montreal</td>
<td>19:30</td>
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<tr>
<td>AC 123</td>
<td>12:30 Calgary - Toronto</td>
<td>16:30</td>
</tr>
<tr>
<td>AC 123</td>
<td>16:45 Toronto - Montreal</td>
<td>17:30</td>
</tr>
</tbody>
</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

<table>
<thead>
<tr>
<th>Drug</th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
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<tbody>
<tr>
<td>Inderal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lanoxin</td>
<td></td>
<td></td>
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<tr>
<td>Carafate</td>
<td></td>
<td></td>
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<tr>
<td>Quinag</td>
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<td></td>
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</tr>
<tr>
<td>Zantac</td>
<td></td>
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</tr>
<tr>
<td>Couma</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Organized by both time of day and by drug
Which representation is best? Depends 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? (Geographic Navigation)

Detailed navigation plus precision

General navigation plus orientation

GAME PAUSED
Press F3 to Continue
Where am I? (File System Navigation)

Where am I? (Revealing Patterns Interactively)

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

Right-click menu + properties

**Why can’t I sort folders by size?**

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

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

What stock is doing best?
Which folder is using the most drive space?

What’s going on in the world?

- EU support for Arab rebels is shamefully late
- Libyan rebels flee Port Brega as Gaddafi forces advance
- Libya: Gaddafi forces rout rebels in eastern Libya
- Gaddafi forces rout rebels in eastern Libya
- Violence undermines conclusion between Yemeni ruling party, opposition
- Yemeni regime's collapse in Jibreen is on the verge of Military forces to exit by the end of the week
- 100,000 fpd has begun in Japan's Minami region
- Tornado causes 5 people in Switzerland
- Gaddafi forces attack Darfur
- Strongholds
- Save our, boy rebels driven out of key city; by relentless onslaught of...
- Charlie Sheen — wasn't he a film actor in the Eighties?
- Japanese authorities rush to save lives, avert nuclear crisis
- Bookie refund Binocular bets
- Ponting - We were rusty
- Ponting - We were rusty
- Aborted end of the World Cup
- Feasibility of more blizzards
- Сhina's nuclear power facilities to be closed
- Japan's tsunami： lessons from the past
- Scotland braces for more blizzards
- Feasibility for Britons after Japan quake
- Japan tsunami： lessons from the past
- Scotland braces for more blizzards
- Feasibility for Britons after Japan quake
Who won the 2008 Presidential elections, by how much?

By state...
Who won the 2008 Presidential elections, by how much?

By county...

By percentage...
**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*
Six Variables Shown:

Data Density
New York Weather History
• 181 numbers/sq inch
Small Multiples: Showing Time and Change

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.
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

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<table>
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<td>Improvement</td>
<td>Total assets</td>
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<td>66,850</td>
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<td>79,290</td>
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<td>80,260</td>
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<td>306.0</td>
<td>85,500</td>
<td>141,730</td>
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</tbody>
</table>

Metaphors (II)

Control Panels with familiar controls

Name: ____________________
Address: ____________________
City: ____________________
Province: ____________________
Postal Code: ____________________

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)

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**Advantages**

- Pick a setting and reuse it
- Often more efficient

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**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

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
- action-object versus object-action

Quick Recap (not exhaustive)

These three components are the foundation of a true Visual Interface
Closing Thoughts...

"If a picture is worth 1000 words, then an interface is worth 1000 pictures."

Keep user tasks and goals in mind.

Encourage exploration but don't overwhelm the users.

Overview, zoom, filter, details on demand.