Tufte’s Design Principles

CS 4460 – Intro. to Information Visualization
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Please see appropriate books for missing images

Learning Objectives

• Understand and be able to apply Tufte's principles:
  – Graphical integrity (baselines, size coding)
  – Maximize data-ink ratio
  – Avoid chartjunk
  – Macro/micro-readings
  – Small multiples
  – Minimize/unite grids, labeling, legends
  – Appropriate applications of color
Today’s Agenda

Graphical Excellence

• Principles
  – Graphical excellence is the well-designed presentation of interesting data---a matter of substance, of statistics, and of design
  – Graphical excellence consists of complex ideas communicated with clarity, precision and efficiency

According to Tufte
Graphical Excellence

• Principles
  – Graphical excellence is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space
  – Graphical excellence is nearly always multivariate
  – And graphical excellence requires telling the truth about the data

Summary

• 1. Tell the truth
  – Graphical integrity
• 2. Do it effectively with clarity, precision...
  – Design aesthetics

Let’s look at each of these
1. Graphical Integrity

- Your graphic should tell the truth about your data

Example

Stock market crash?
Example

Show entire scale

Example

Show in context
Chart Integrity

- Where’s baseline?
- What’s scale?
- What’s context?

Vol 1, p. 54 (1)

Where’s 0?
Note middle ‘70
Huge Difference?

**SHOULD BRITAIN LEAVE EU?**

59% 55%
54% 54%
49% 49%
44% 44%
39% 39%
34% 34%

Leave Remain

Source: Ipsos MORI

Compare area of right bar to that of the left bar

Huge Difference?

**IF BUSH TAX CUTS EXPIRE**

35% 38.6%
30% 42%
35% 40%
30% 38.6%
34% 36%
35% 37%

NOW JAN. 1, 2013

Compare area of right bar to that of the left bar
Vol 1, p 54 (2)

What's being compared?

Vol 1, 57

Scale?
Great work!

Ahhhh

Show the context
Local Example

A huge rise?

Atlanta Journal Constitution
Summer '08

More of the data

Atlanta Journal Constitution
Dec. '08
A Redesign


Gun deaths in Florida

Number of murders committed using firearms

2005 Florida enacted its 'Stand Your Ground' law

Source: Florida Department of Law Enforcement

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Watch Size Coding

- Height/width vs. area vs. volume
area = value?

volume = value?
Circle Width vs. Area

http://www.huffingtonpost.com/randy-krum/false-visualizations-when_b_5736106.html

Areas? Not Sure

Measuring Misrepresentation

• Visual attribute value should be directly proportional to data attribute value

\[
\text{Lie factor} = \frac{\text{Size of effect shown in graphic}}{\text{Size of effect in data}}
\]

p.62 \quad 9.4 = \frac{4280}{454} \quad \text{oil barrels}

2. Design Aesthetics

• Set of principles to help guide designers
Design Principles

• Maximize data-ink ratio

\[
\text{Data ink ratio} = \frac{\text{Data ink}}{\text{Total ink used in graphic}}
\]

= proportion of graphic’s ink devoted to the non-redundant display of data-information

Vol 1, p. 94
More...

- Above all else, show the data
- Maximize the data-ink ratio
- Erase non-data-ink
- Erase redundant data-ink
- Revise and edit
More...

- Maximize data density

\[
data \text{ density of graphic} = \frac{\text{number of entries in data matrix}}{\text{area of data graphic}}\]

Quote ...

Maximize Data Density

“Data-rich designs give a context and credibility to statistical evidence. Low-information designs are suspect: what is left out, what is hidden, why are we shown so little? High-density graphics help us to compare parts of the data by displaying much information within the view of the eye: we look at one page at a time and the more on the page, the more effective and comparative our eye can be. The principle, then, is:

Maximize data density and the size of the data matrix, within reason.”

Vol 1, p 168
Redesign charts

- Bar chart, scatter plot, box plot

Bar chart
Bar chart

Bar chart
Box plot

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Box plot

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Scatter plot

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Scatter plot

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Design Principles

- Avoid chartjunk
  - Extraneous visual elements that detract from message
A classic

Diamonds Were A Girl’s Best Friend

USA Today

http://www.usatoday.com/news/snapshot.htm (formerly)
Junk Charts Blog

http://junkcharts.typepad.com/

More Thoughts

Great narrative: Vol.2, bottom page 33-34
Design Principles

• Utilize multifunctioning graphical elements (macro/micro readings)
  – Graphical elements that convey data information and a design function
US Army Divisions going to France in WW I

Leonard P. Ayres
*The War with Germany*
1919

Vol 2, p. 37

Manhattan 1989
Manhattan Map Company
Viet Nam Memorial
in Washington D.C.

Maya Ying Lin

58,000+ dead soldiers
Vol 2, p. 43

Names listed chronologically by death

Design Principles

• Use small multiples
  – Repeat visually similar graphical elements nearby rather than spreading far apart
Vol 1, p. 170

23 hours of LA air pollution

Vol 1, p. 173

Chromosomes of man, chimpanzee, gorilla & orangutan
Vol 2, p. 68

How to draw letters

Vol 2, p. 69

Calligraphy
More Recent Additions

Sparklines

Small, repeated graphics (frequently line graphs)

Sparkline Examples
Design Principles

- Content is king
  - Quality, relevance and integrity of the content is fundamental
  - What’s the analysis task? Make the visual design reflect that
  - Integrate text, chart, graphic, map into a coherent narrative

Graph and Chart Tips

- Avoid separate legends and keys -- Just have that information in the graphic
- Make grids, labeling, etc., very faint so that they recede into background
Before

New Jersey Transit

After
Using Color Effectively

• “The often scant benefits derived from coloring data indicate that even putting a good color in a good place is a complex matter. Indeed, so difficult and subtle that avoiding catastrophe becomes the first principle in bringing color to information:  *Above all, do no harm.*"
Proper Color Use

- To label
- To measure
- To represent or imitate reality
- To enliven or decorate

Examples

- The bad...
Description

“..despite its clever and multifunctioning data measure, formed by crossing two four-colored grids, this is a puzzle graphic. Deployed here, in a feat of technological virtuousity, are 16 shades of color spread on 3,056 counties, a monument to a sophisticated computer graphics system. But it is surely a graphic experienced verbally not visually. Over and over, the viewers must run little phrases through their minds, trying to maintain the right pattern of words to make sense of the visual montage: “Now let’s see, purple represents counties where there are both high levels of male cardiovascular disease mortality and 11.6 to 56.0 percent of the households have more than 1.01 persons per room...”
“Color’s multidimensionality can also enliven and inform what users must face at computer terminals, although some color applied to display screens has made what should be a straight-forward tool into something that looks like a grim parody of a video game.”
Examples

• The good...
Guides for Enhancing Visual Quality

- Attractive displays of statistical info
  - have a properly chosen format and design
  - use words, numbers and drawing together
  - reflect a balance, a proportion, a sense of relevant scale
  - display an accessible complexity of detail
  - often have a narrative quality, a story to tell about the data
  - are drawn in a professional manner, with the technical details of production done with care
  - avoid content-free decoration, including chartjunk
Information Overload

What about confusing clutter? Information overload? Doesn’t data have to “boiled down” and “simplified”? These common questions miss the point, for the quantity of detail is an issue completely separate from the difficulty of reading. Clutter and confusion are failures of design, not attributes of information. Often the less complex and less subtle the line, the more ambiguous and less interesting is the reading. Stripping the detail out of data is a style based on personal preference and fashion, considerations utterly indifferent to substantive content. Vol. 2, p. 51

Minard graphic

<table>
<thead>
<tr>
<th>size of army</th>
<th>latitude</th>
<th>temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>direction</td>
<td>longitude</td>
<td>date</td>
</tr>
</tbody>
</table>

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Graphical Displays Should

- Show the data
- Induce the viewer to think about substance rather than about methodology, graphic design the technology of graphic production, or something else
- Avoid distorting what the data have to say
- Present many numbers in a small space
- Make large data sets coherent
- Encourage the eye to compare different pieces of data
- Reveal the data at several levels of detail, from a broad overview to the fine structure
- Serve a reasonably clear purpose: description, exploration, tabulation, or decoration
- Be closely integrated with statistical and verbal descriptions of a data set

Website & Seminar
Discussion Forum

Interesting Contrast

Nigel Holmes
http://www.nigelholmes.com
More Bad Examples

http://viz.wtf/

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Upcoming

• Storytelling/Communication
  – Prep: The Fallen of WWII video

• Lab: D3 Enter, Update, & Exit
  – Prep: Murray, chapter 9

Sources Used

E. Tufte, *The Visual Display of Quantitative Information*
E. Tufte, *Envisioning Information*
E. Tufte, *Visual Explanations*