

Chapter 2: The Gospel According to Tufte

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2.1 Data-Ink

- Definition of Data-Ink
 - The non-erasable core of a graphic
 - Data-Ink Ratio
 - * $\text{Data-Ink} / \text{Total ink use to print the graphic}$
- Tufte's Five Laws of Data-Ink:
 - Above all else show the data
 - Maximize the data-ink ratio
 - Erase non-data-ink
 - Erase redundant data-ink
 - Revise and Edit

2.1.1 Show the Data

- Context is a mixture of good graphs and explanations that orient the reader like the compass rose on a map

2.1.2 Emphasize the Data

- All graphics require some non-data elements:
 - Axis lines, tic marks, labels, etc.

2.1.3 Erase Non-Data-Ink or Down with the Grid!

- Use of gridlines before the computer age due to hand-drawn graphics Exception to use of grid in graphics:
 - Nomogram: graphical calculator When author expects reader to carefully study curve and determine local maxima and minima
 - * Qualitative nomography
 - Three-Dimensional Diagrams
 - * Grid carries a message
 - * Pierre Welander: the grid was to facilitate the conversation fo the data curve into numerical values

- Key guidelines for a grid:
 - Don't use a grid unless you really have to
 - Make the grid line faint compared to the data-curves
 - * Grid as thin as lines or dotted lines
 - * Use thick line for the data

2.1.4 Erase Non-Data-Ink: Hurrah for Half-Framing!

- Half-Framing: drawing only the usual horizontal and vertical axes and omitting framing lines on the top and right

2.1.5 Erase Non-Data-Ink: Example of the Simplified Bar Graph

- Bar chart to illustrate that excess can be erased in a chart without compromising the data

2.1.6 Erase Redundant Data-Ink: Symmetry and Wrap-Around and All That

- Redundancy is sometimes needed for complicated visualization
 - Redundancy is good depending on context and readership

2.1.7 Erasing: Eliminating the Graph Entirely

- Sometimes to deal with a flawed graph, eliminate the illustration entirely, and use a table instead

2.1.8 Revise and Edit

Intellectual content is not changed by editing, only the clarity * 1. Experiment: try several versions of the same figure * 2. Redundancy is a matter of subtle judgement(+ Redundancy should be there for a reason

2.2 High Data Density

- Data Density = Number of entries in data array / Area of data graphic
- High Density Graphs: identify key themes or goals of the figure

2.2.1 The Shrink Principle

- Drink Principle: Graphics can be shrunk way down
- It is much easier to grasp a set of related figures if they are all on one place in a single multi-panel figure rather than scattered over many pages

2.3 Multifunctioning Graphical Elements

- Mobilize every graphical element, perhaps several times over, to show the data

2.4 Small Multiples or Animations-on-a-Page

- Animations: individual grams must differ by a small amount
- Small Multiple Figure: collection of miniature illustrations, arrayed as a single figure, to be perceived as one
 - Each multi-panel figure must be the same size, same graph species, and all other aspects of the design
- Animations:
 - Shows only six different times
 - Each time is illustrated in two different ways
 - * Mesh plot
 - * Contour graph
- Interpolate: Morphing if there are too few frames to make it smooth and pleasing to the eye
- Small multiple graph \longleftrightarrow one animation with morphing between frames

2.5 One Plus One is Three

- Questions to ask:
 - What to include?
 - How do these parts interact?, What should be emphasized?, Can data curves be easily picked out?

2.6 Layering, Separation and Rubrication

- Emphasis of separation through color or grayscale

2.7 Word-Labels Are Better Than Letter-Labels

- Make labels as clear and explicit on the graph
- Write out labels as whole words or numbers

2.8 Collapsing a Dimension or Escaping Flatland

- Ten dimensions, but compacted and have no visible roles
- Experiment: Plot the data in several different forms, and publish an illuminating subset of the graphs

2.9 Supplementary Material

2.9.1 Small Multiples or Animations-on-a-Page

- All frames are shown in single row with identical format for easy comparison
- Important features are marked with arrows and numerical labels

2.9.2 Separation: Inset Graphs

- Use of large graph/inset graph visual format ties two graphs together

2.10 Wide is Wonderful: Aesthetics of Aspect Ratio

- External Aspect Ratio: ratio of width to height as it appears on the printed page
 - $R_e = \text{width on page} / \text{height on page}$
- Reasons:
 - Human visual system
 - Wider is better

2.11 Color or Why the Rainbow Isn't Golden

- Color is most powerful but also easier to misuse
- 5% - 10% red-green color blindness
 - Two-color scheme should avoid red and green
 - Rainbow palette of colors will create problems for color-blind

2.12 Parallelism

- Multiple images are combined in parallel, message is easier to grasp because axes, format are constant

2.13 The Friendly Graphic

- Friendly:
 - Words spelled out
 - Words run left to right
 - Little messages help explain data
 - Labels are placed on graphic; avoid legends
 - Graphics attract viewer
 - Colors are strategic and avoid color-blindness
 - Type is clear
 - Type is upper and lower case