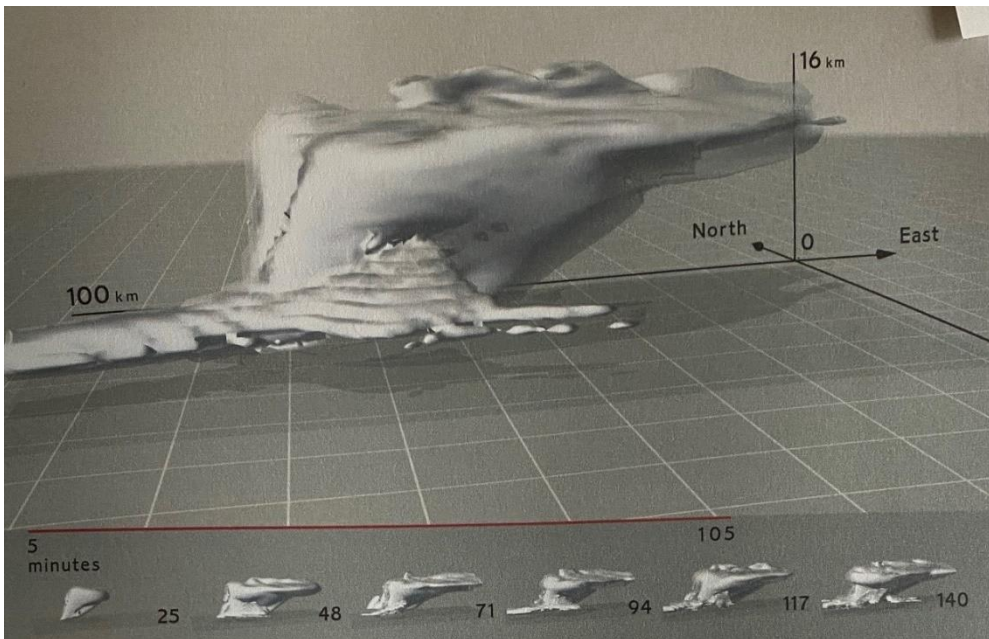
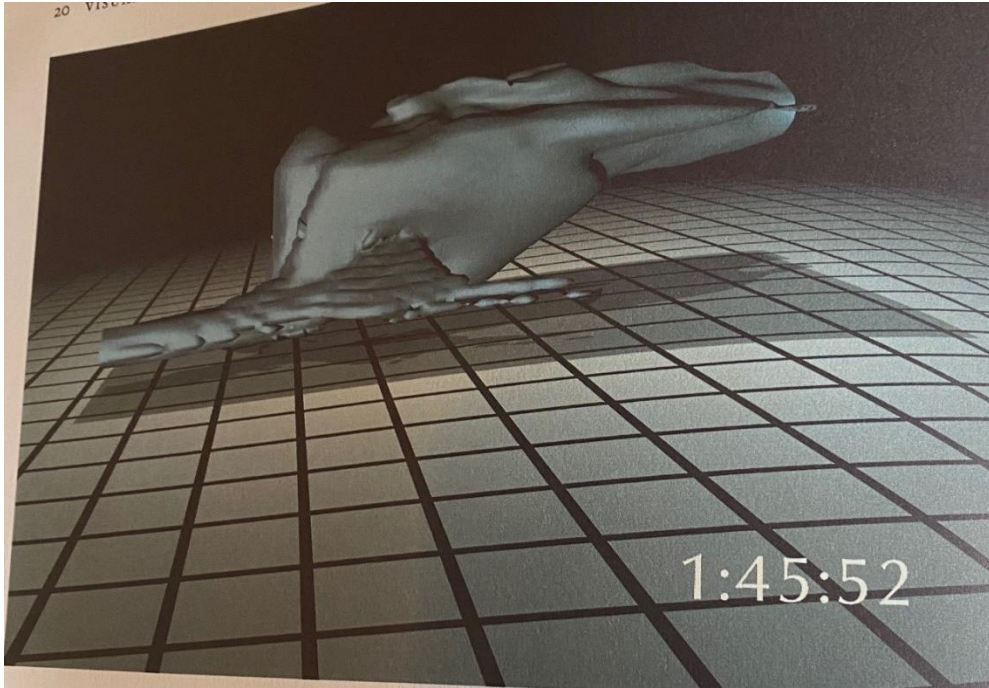


# *On Edward Tufte*

By Blas Moros

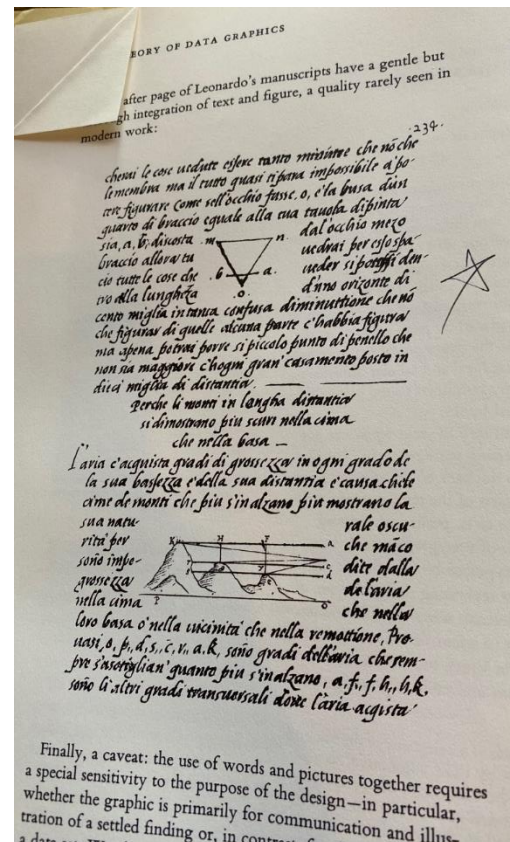
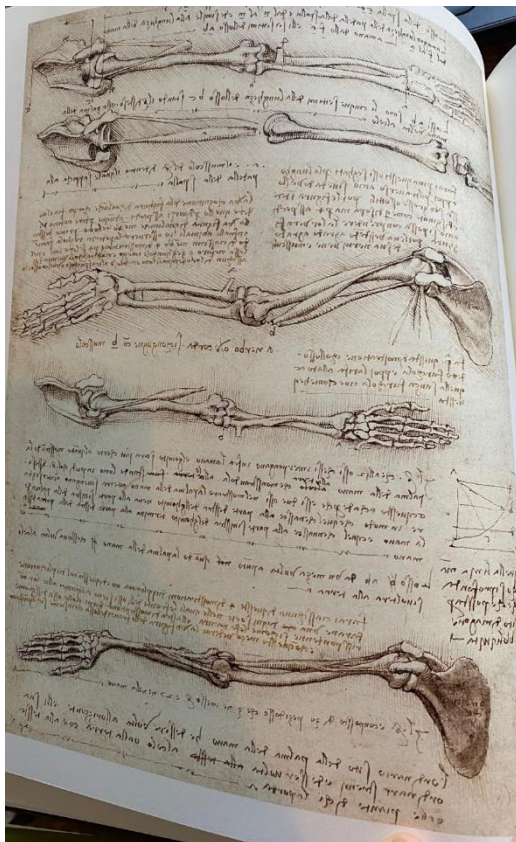


## Intro

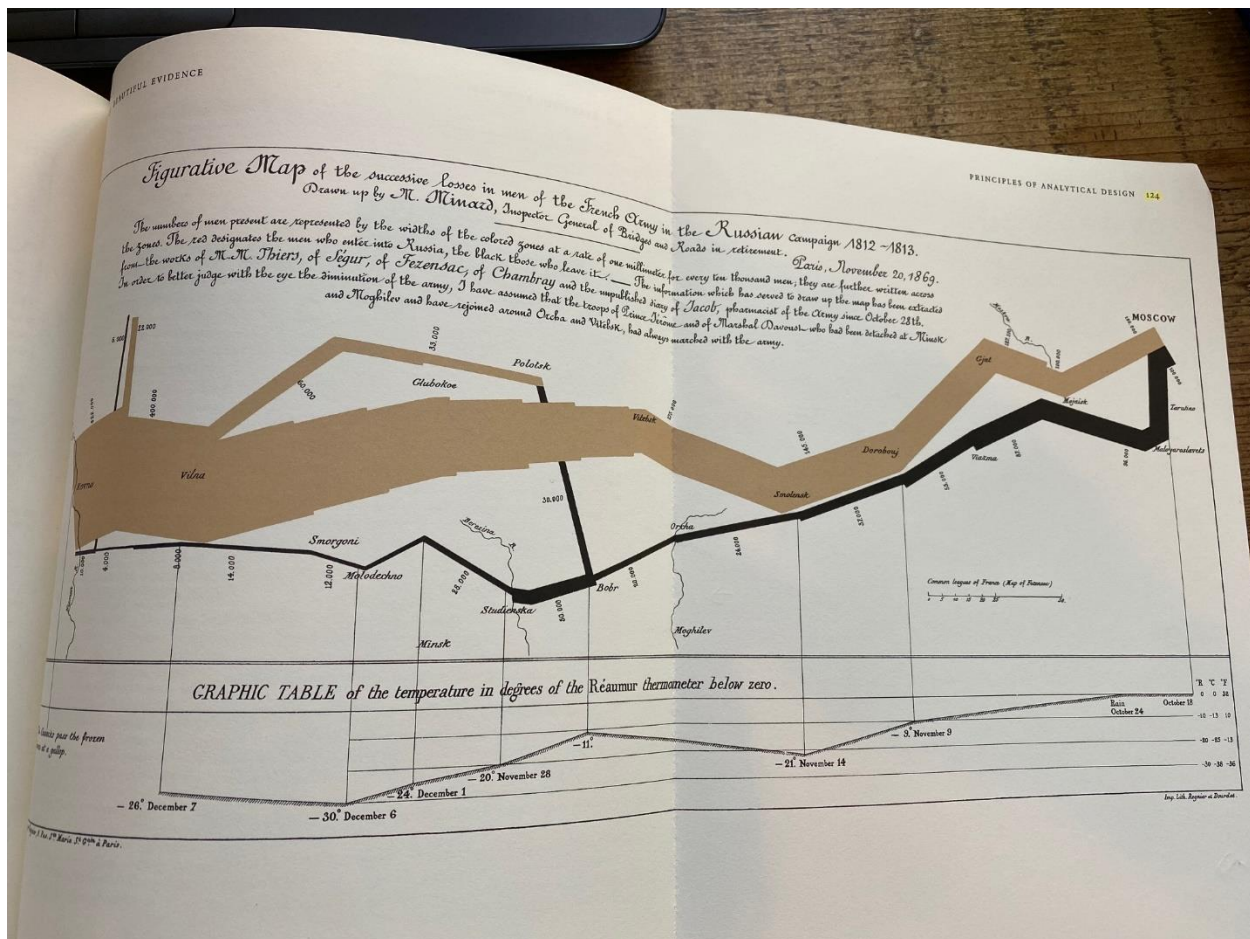
The hope is that this “[teacher’s reference guide](#)” provides some color on Edward Tufte and his key principles on design and data presentation/visualization. This guide covers his 4 books: [Beautiful Evidence](#), [The Visual Display of Quantitative Information](#), [Envisioning Information](#), and [Visual Explanations](#).

Tufte is the godfather of this field and his influence is felt throughout technology, media, and academia. He seeks a more unified, holistic, and integrated model which makes learning more accurate, intuitive, simple, and fun.

One of my key takeaways is that we should combine visuals, text, and data as often as possible as long as it is done in a correct and simple manner. This was more common before computers as da Vinci’s journals and Minard’s data map beautifully show:



Da Vinci's journal, [Beautiful Evidence](#) by Edward Tufte



Minard's Figurative Map, [Beautiful Evidence](#) by Edward Tufte

Charles Joseph Minard's data-map showing Napoleon's invasion and retreat of Russia may be one of the best designed diagrams of all-time.

1. Principle 1: Comparisons - show comparisons, contrasts, differences
2. Principle 2: Causality, mechanisms, structure, explanation - show causality, mechanism, explanation, systemic structure
3. Principle 3: Multivariate Analysis - show multivariate data; show more than 1 or 2 variables
4. Principle 4: Integration of Evidence - completely integrate words, numbers, diagrams
5. Principle 5: Documentation - thoroughly describe the evidence. Provide a detailed title, indicate the authors and sponsors, document the data sources, show complete measurement scales, point out relevant issues.
6. Principle 6: Content counts most of all - analytical representations ultimately stand or fall depending on the quality, relevance, and integrity of their content

This sort of interweaving is not as natural or easy to accomplish with computers, but it should be the model as it significantly improves the reader's rate of absorption.

I also very much appreciated the recursive nature of Tufte's books. His books are "self-exemplifying," proving the principles he is trying to make.

*"I sought to make this book self-exemplifying - that is, the physical object itself would reflect the intellectual principles advanced in the book. Publishers seemed appalled at the prospect that an author might govern design. So, I sought to self-publish... To finance the book, I took out another mortgage on my home. The bank officer said this was the second most unusual loan that she had ever made; first place belonged to a loan to a circus to buy an elephant!"* – Edward Tufte, [The Visual Display of Quantitative Information](#)

I have been studying Tufte's work with a specific project in mind (to be revealed soon), but his key tenets are important and applicable for anybody seeking to better understand how to use data and visualizations to most effectively teach others, make effective presentations, and, inversely, to understand why certain images and techniques are ineffective.

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.

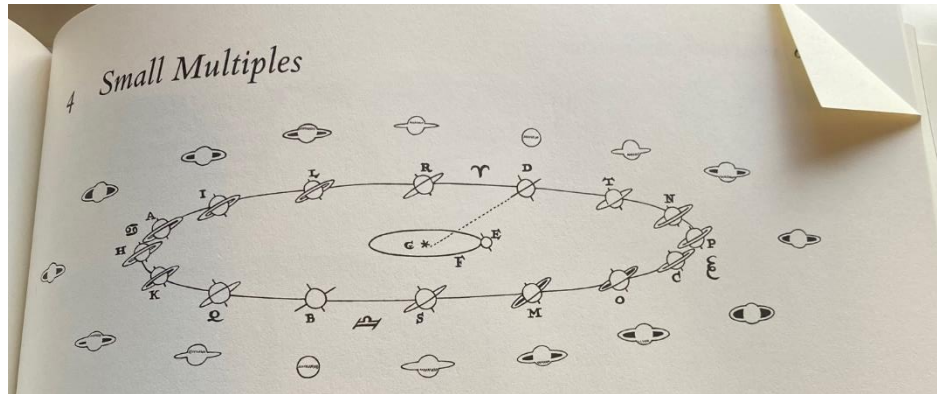
– Edward Tufte

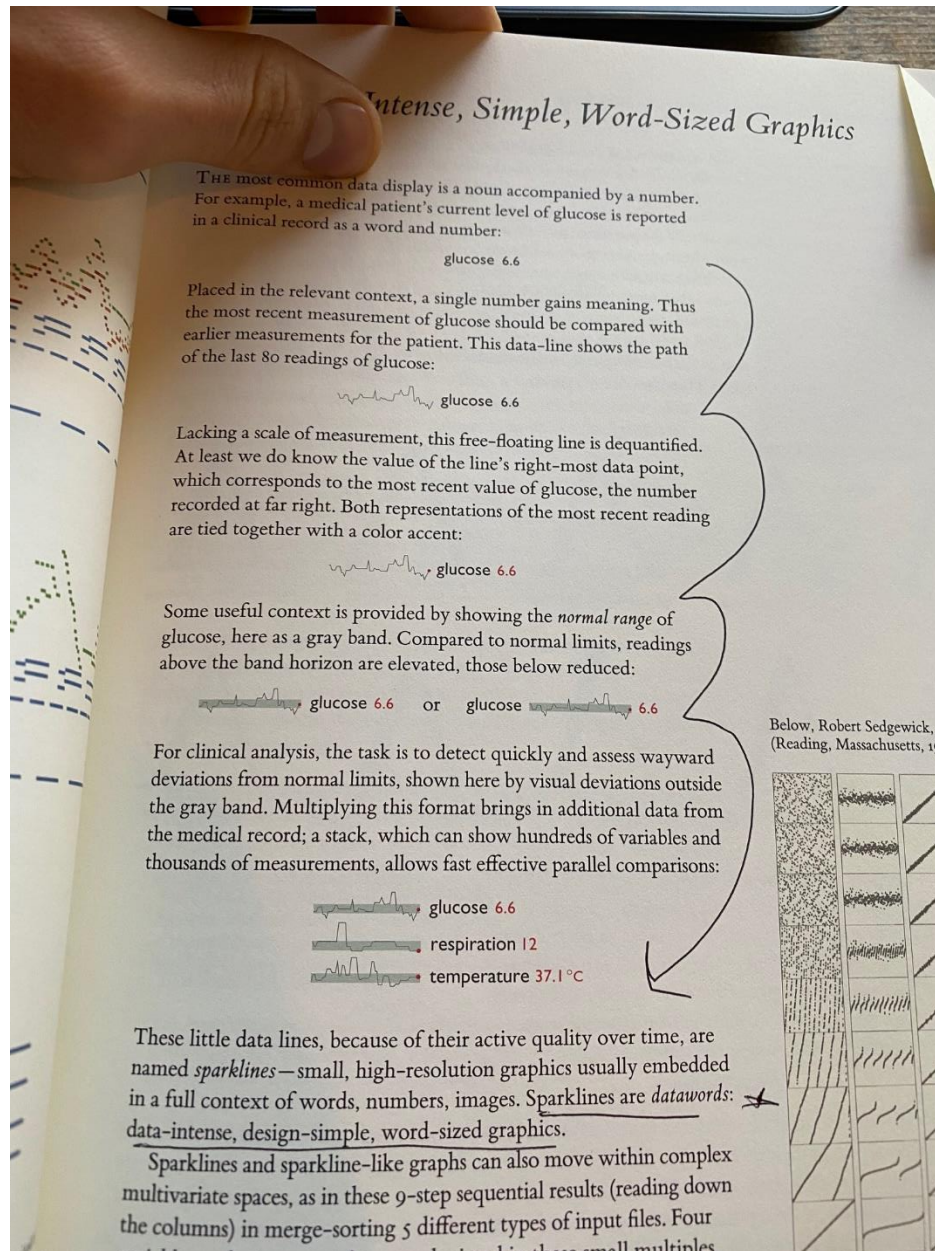
Please note that I am no expert. There are surely flaws throughout and parts which true experts would disagree with. I welcome any questions, comments, and corrections in the quest to better understand Edward Tufte and his design principles.

*So, what does graphical excellence look like?*

1. Graphical excellence is the well-designed presentation of interesting data - a matter of substance, of statistics, of design
2. 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
3. Excellence in statistical graphics consists of complex ideas communicated with clarity, precision, and efficiency. Graphical displays should:
  1. show the data
  2. induce the viewer to think about the substance rather than about methodology, graphic design, the technology of graphic production, or something else
  3. avoid distorting what the data have to say
  4. present many numbers in a small space
  5. make large data sets coherent
  6. encourage the eye to compare different pieces of data
  7. reveal the data at several levels of detail, from a broad overview to the fine structure
  8. serve a reasonably clear purpose: description, exploration, tabulation, or decoration
  9. be closely integrated with the statistical and verbal descriptions of a data set
4. Excellence, nearly always of a multivariate sort, is illustrated here for fundamental graphic designs: data maps, time-series, space-time narrative purposes, providing a set of high-quality graphics that can be discussed in constructing a theory of data graphics
5. Attractive displays of statistical information:
  1. have a properly chosen format and design
  2. use words, numbers, and drawings together
  3. reflect a balance, a proportion, a sense of relevant scale
  4. display an accessible complexity of detail
  5. often have a narrative quality, a story to tell about the data
  6. are drawn in a professional manner, with the technical details of production done with care
  7. avoid content-free decoration, including chartjunk

6. At the heart of quantitative reasoning is a single question: *compared to what?* Small multiple designs, multivariate and data bountiful answer directly by visually enforcing comparisons of changes, of the differences among objects, of the scope of alternatives. For a wide range of problems in data presentation, small multiples are the best design solution.



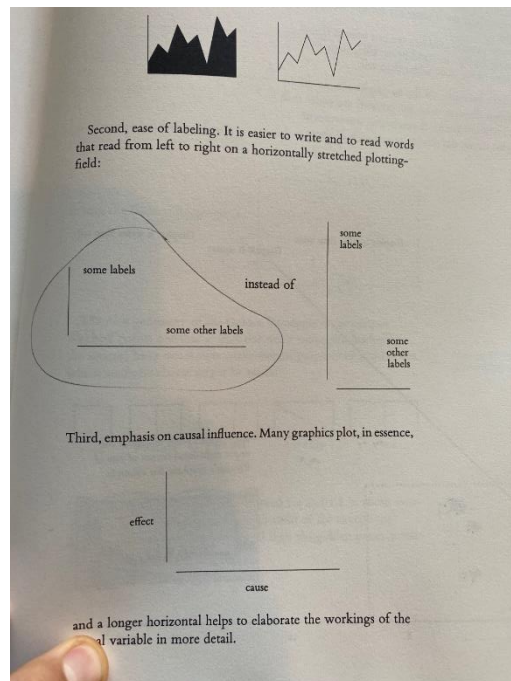


[Beautiful Evidence](#) by Edward Tufte. Notice how much more information can be revealed by adding context through time-series, different colors, a band of what is considered normal, and comparing glucose to other important and relevant markers

- The principles of analytical thinking (and thus analytical design) are universal - like mathematics, the laws of Nature, the deep structure of language - and are not tied to any language, culture, style, century, gender, or technology of information display.



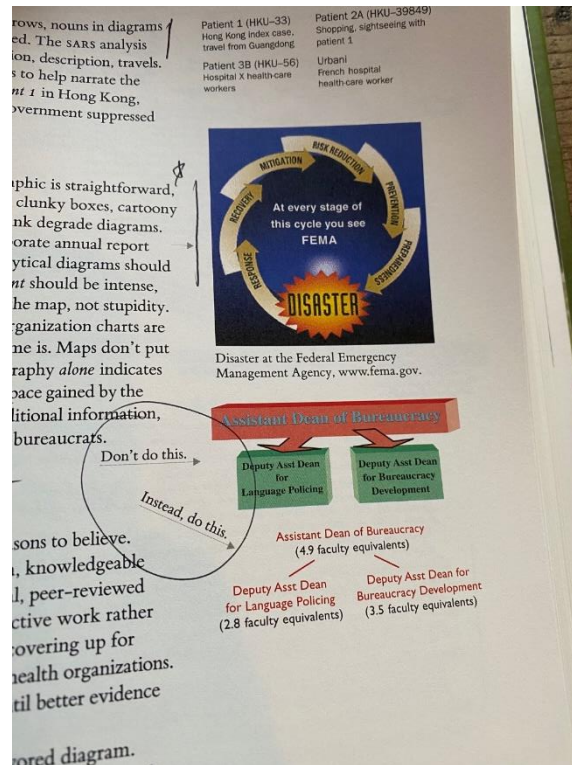
8. The similar treatment of text, diagrams, and images suggests to readers that images are as relevant and credible as words and diagrams. A book design that treats all modes of information alike reinforces the point.
9. Those who discover an explanation are often those who construct its representation
10. Many of our examples suggest that clarity and excellence in thinking is very much like clarity and excellence in the display of data. When principles of design replicate principles of thought, the act of arranging information becomes an act of insight
11. Jonson's Principle - these problems are more than just poor design, for a lack of visual clarity in arranging evidence is a sign of a lack of intellectual clarity in reasoning about evidence.
12. Numbers become evidence by being in relation to
13. Graphs are best understood when they are longer than they are tall



14. Tables without vertical rules look better; thin rules are better than thick ones
15. A most unconventional design strategy is revealed: to clarify, add detail. Clutter and confusion are failures of design, not attributes of information. What we seek is not necessarily simplicity, but an understanding of complexity revealed with an economy of means

16. Visual displays rich with data are not only an appropriate and proper complement to human capabilities, but also such designs are frequently optimal. Micro/macro designs enforce both local and global comparisons and, at the same time, avoid the disruption of context switching. All told, exactly what is needed is for reasoning about information
17. It is not how much information there is, but rather how effectively it is arranged. Showing complexity often demands hard, thoughtful work. Detailed micro/macro designs have substantial costs for data collection, design, custom computing, image processing, and production - expenses similar to that of first-class cartography.
18. Clear logic of data display and analysis includes:
  1. Placing the data in an appropriate context for assessing cause and effect
  2. Making quantitative comparisons. The deep, fundamental question in statistical analysis is *compared to what?*
  3. Considering alternative explanations and contrary cases. Sometimes it can be difficult for researchers - who both report and advocate their findings - to face up to threats to their conclusions, such as alternative explanations and contrary cases. Nonetheless, the credibility of a report is enhanced by a careful assessment of *all* relevant evidence, not just evidence overtly consistent with explanations advanced by the report. The point is to get it right, not to win the case, not to sweep under the rug all the assorted puzzles and inconsistencies that frequently occur in collections of data
19. Assessment of possible errors in the numbers reported in the graphics. Detailed comments on possible errors annotate both the map and the table, reassuring readers about the care and integrity of the statistical detective work that produced the data graphics
  1. Enough exploration must be done so that the results are shown to be relatively insensitive to plausible alternative specifications and data choices. Only in that way can the statistician protect himself or herself from the temptation to favor the client and from the ensuring cross-examination. - John Tukey
20. The smallest effective difference
  1. Make all visual distinctions as subtle as possible, but still clear and effective. Relevant to nearly every display of data, the smallest effective difference is the Occam's razor ("what can be done with fewer is done in vain with more") of information design. And often the happy consequence of an economy of means is a graceful richness of information, for small differences allow more differences.

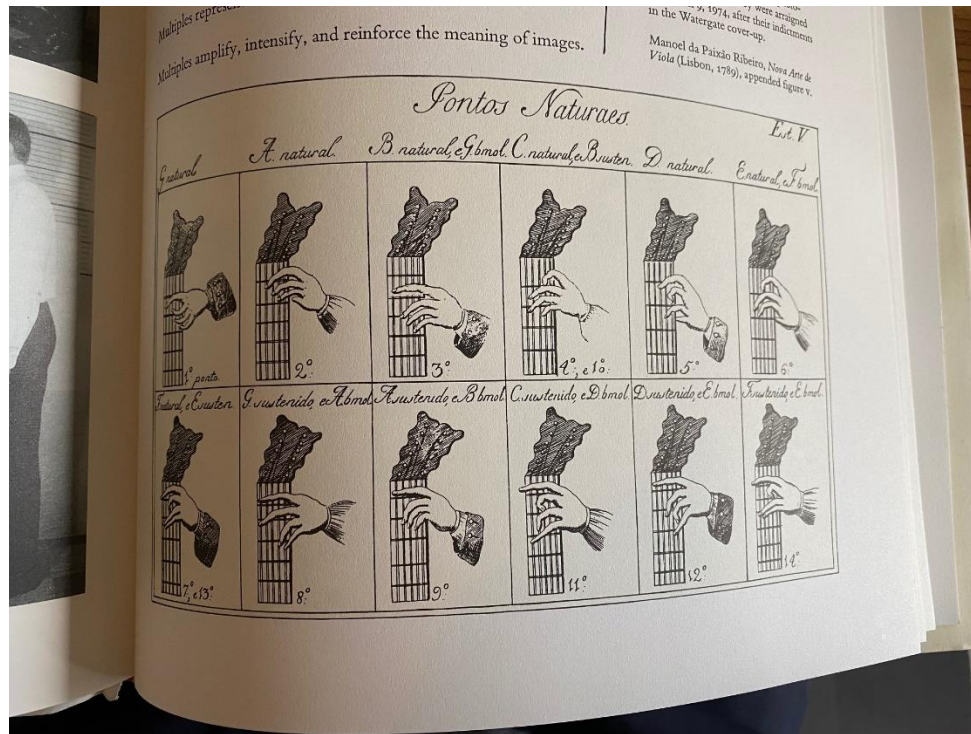
- Minimal distinctions reduce visual clutter. small contrasts work to enrich the overall visual signal by increasing the number of distinctions that can be made within a single image; thus, design by means of small effective differences helps to increase the resolution of our images.



[Beautiful Evidence](#) by Edward Tufte

## 21. Multiples in space and time

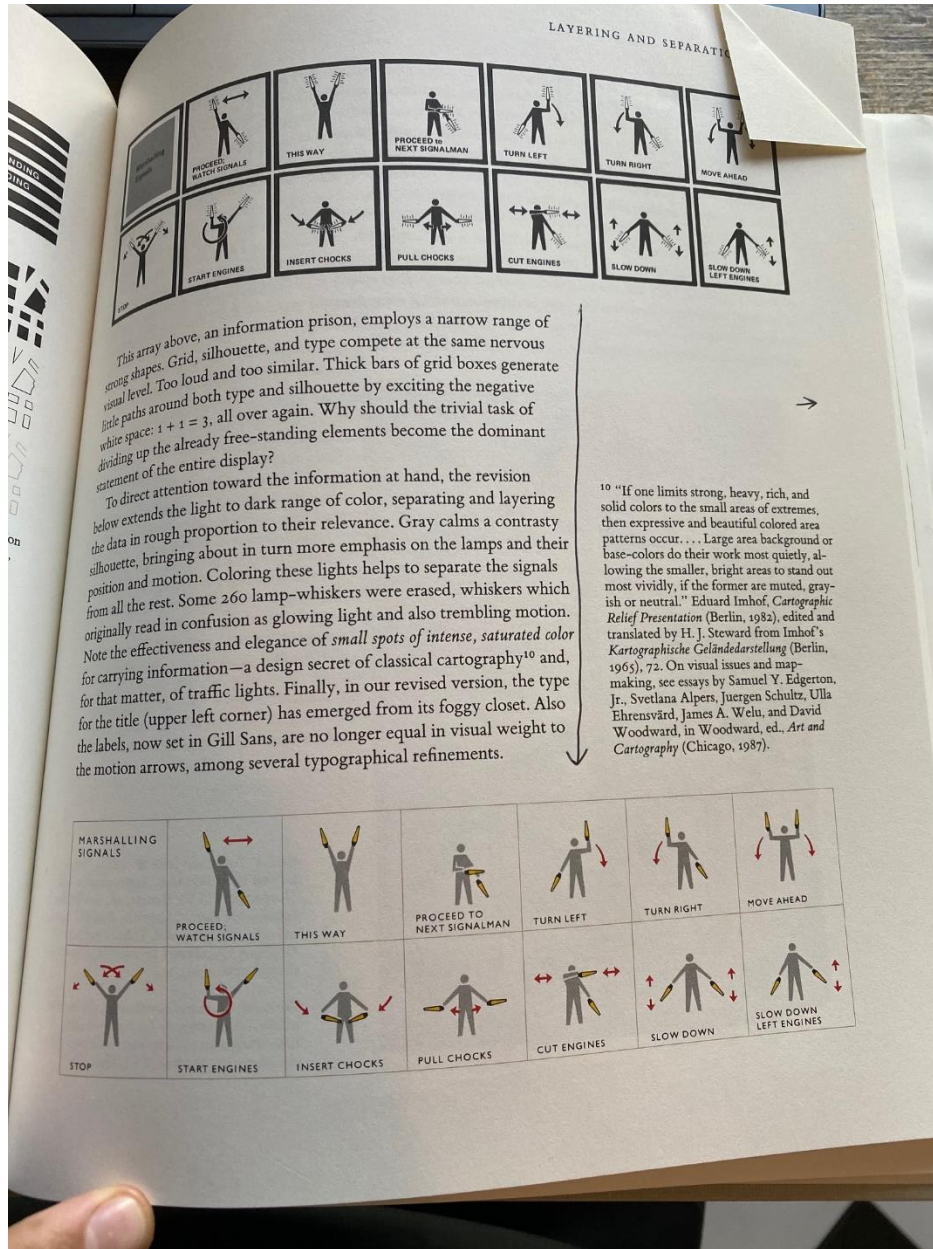
- Multiples images reveal repetition and change, pattern and surprise - the defining elements in the idea of information. Multiples directly depict comparisons, the essence of statistical thinking. Multiples enhance the dimensionality of the flatlands of paper and computer screen, giving depth to vision by arraying panels and slices of information. Multiples create visual lists of objects and activities, nouns and verbs, helping viewers to analyze, compare, differentiate, decide - as we see below with 12 hands in 12 positions for making 12 sounds. Multiples represent and narrate sequences of motion. Multiples amplify, intensify, and reinforce the meaning of images.



2. Multiples help to monitor and analyze multi-variable processes - ordinary occurrences in medicine, finance, quality control, and large-scale industrial and engineering operations. By providing a quick, simultaneous look at a continuing flow of different measurements, multiples help sort out the relevant substance from a flood of numbers.

*What do you want to avoid?*

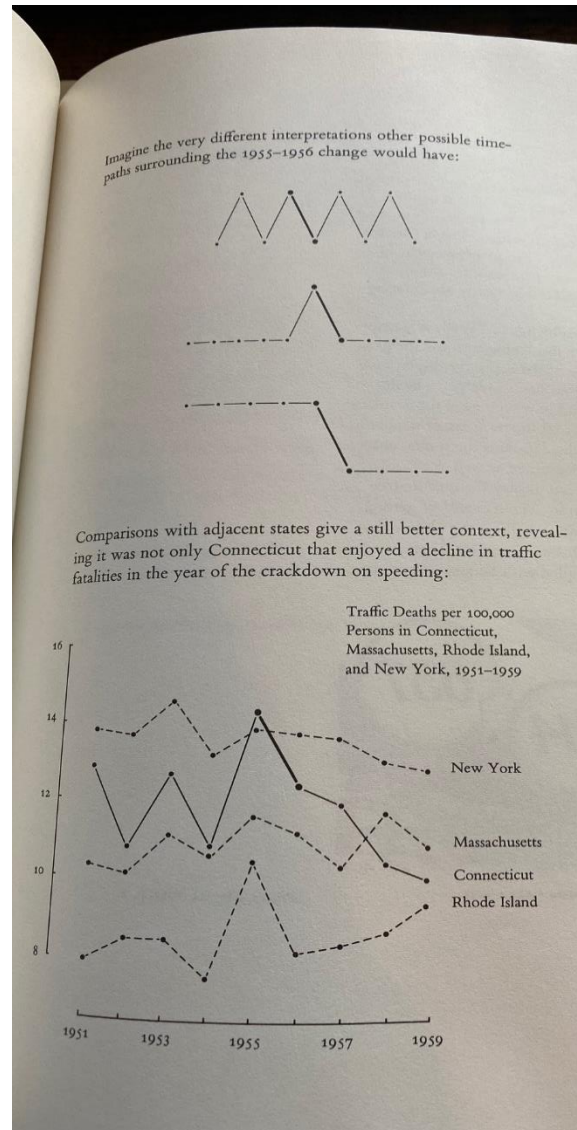
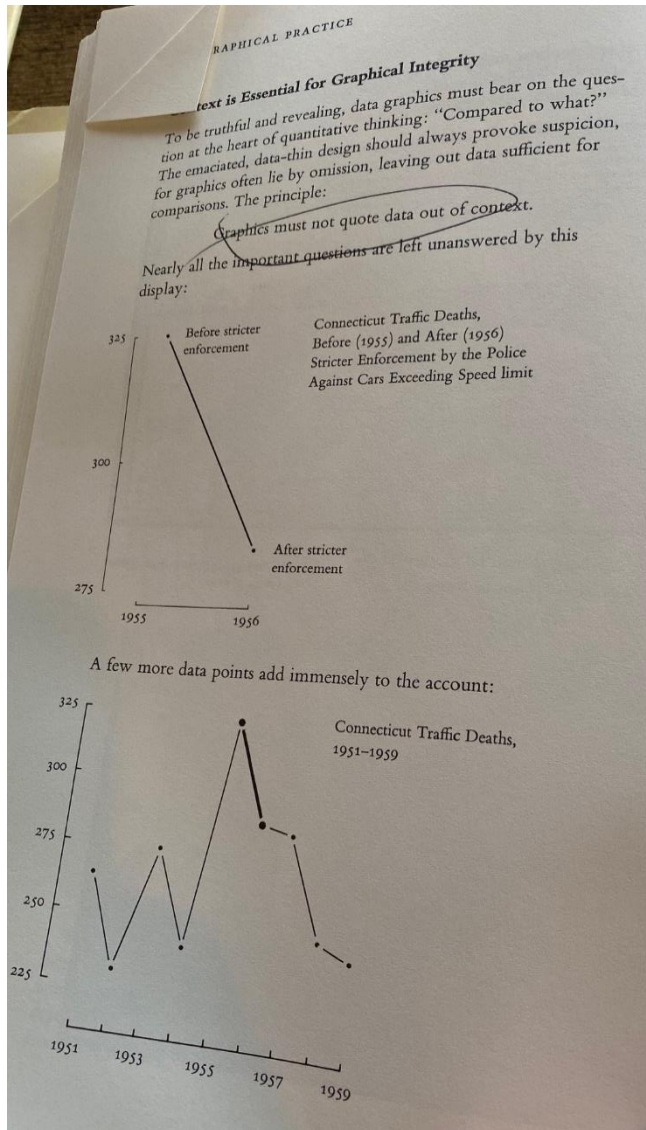
1. Forgo chartjunk, including [moire vibration](#), clunky grids (use gray grids)
  1. Chartjunk - good design brings absolute attention to data. Eliminate anything which doesn't serve that purpose
  2. If the numbers are boring, you've got the wrong numbers. Credibility vanishes in clouds of chartjunk; who would trust a chart that looks like a video game?



[Envisioning Information](#) by Edward Tufte

2. Worse is contempt for our audience, designing as if readers were obtuse and uncaring. Clarity and simplicity are completely opposite simple-mindedness
3. While the eyes are extremely sensitive to color variations, anything more than 20 or 30 colors frequently produce not diminishing but negative returns. Above all, do no harm

4. Graphics must not be quoted out of context:



5. Some further details on friendly vs. unfriendly graphics:



### Accessible Complexity: The Friendly Data Graphic

An occasional data graphic displays such care in design that it is particularly accessible and open to the eye, as if the designer had the viewer in mind at every turn while constructing the graphic. This is the *friendly data graphic*.

There are many specific differences between friendly and unfriendly graphics:

#### Friendly

words are spelled out, mysterious and elaborate encoding avoided

words run from left to right, the usual direction for reading occidental languages

little messages help explain data

elaborately encoded shadings, cross-hatching, and colors are avoided; instead, labels are placed on the graphic itself; no legend is required

graphic attracts viewer, provokes curiosity

colors, if used, are chosen so that the color-deficient and color-blind (5 to 10 percent of viewers) can make sense of the graphic (blue can be distinguished from other colors by most color-deficient people)

type is clear, precise, modest; lettering may be done by hand

type is upper-and-lower case, with serifs

#### Unfriendly

abbreviations abound, requiring the viewer to sort through text to decode abbreviations

words run vertically, particularly along the Y-axis; words run in several different directions

graphic is cryptic, requires repeated references to scattered text

obscure codings require going back and forth between legend and graphic

graphic is repellent, filled with chartjunk

design insensitive to color-deficient viewers; red and green used for essential contrasts

type is clotted, overbearing

type is all capitals, sans serif



## *Presentation Skills*

1. Making a presentation is a moral act as well as an intellectual activity
2. PowerPoint is a competent slide manager, but it should not impose its cognitive style on our presentations. Instead of showing a few informal talking points on a slide, why not print out an agenda for everyone?
3. For serious presentations, replace PP with word-processing or page-layout software. Making the transition in large organizations requires a straightforward executive order: from now on your presentation software is Microsoft Word, not PP. Get used to it
4. At a talk, paper handouts of technical reports effectively show text, data graphics, images. Printed materials bring information transfer rates in presentations up to that of everyday material in newspapers, reports, books, and internet news sites. An excellent paper size is 11x17 inches, folded in half to make 4 pages. That one piece of paper can show the content-equivalent of 50 to 250 typical PP slides. Serious presentations might begin by handing out this paper and having the group read it. Following the reading period, the presenter might provide a guided analysis of the briefing paper and then encourage and perhaps lead a discussion of the material at hand.
5. Presenting Techniques
  1. These techniques of disinformation design [magic], when reversed, reinforce strategies of presentation used by good teachers. Your audience should know beforehand what you are going to do; then they can evaluate how your verbal and visual evidence supports your argument. And so, we have some practical advice for giving a talk or paper:
    1. Near the beginning of your presentation, tell the audience: what the problem is, why the problem is important, what the solution to the problem is.
    2. If a clear statement of the problem cannot be formulated, then that is a sure sign that the content of the presentation is deficient. Repeated variations on the same idea will often clarify and develop an idea.
  2. To explain complex ideas, use the method of PGP: Particular - General - Particular
    1. Seek to maximize the rate of information transfer to your audience. Yet many presentations rely on low-resolution devices to communicate information - reading aloud from images projected up on the wall from computer screens or from the dreaded overhead projector, or talk, talk,



talk. Instead, try a high-resolution method: No matter what, give everybody in the audience one or more pieces of paper, packed with material related to your presentation. Handouts show pictures, diagrams, data tables, research methods, references, names of people at the meeting, or the complete text of the paper outlined in your talk. Unlike evanescent projected images, permanent and portable paper has credibility. Paper serves as a testimonial record documenting your talk, letting your audience know that you take responsibility for what you say. People can file your handouts away and then come back in a month and ask, "Didn't you say this?"

3. Analyze the details of your presentation; then master those details by practice, practice, practice
4. Show up early. Something good is bound to happen
5. Finish early
6. Questions to ask about your data/presentation
  1. Is the display revealing the truth?
  2. Is the representation accurate?
  3. Are the data carefully documented?
  4. Do the methods of display avoid spurious readings of the data?
  5. Are appropriate comparisons and contexts shown?

## Appendix

1. *The Visual Display of Quantitative Information* by Edward Tufte
2. *Envisioning Information* by Edward Tufte
3. *Visual Explanations: Images and Quantities, Evidence and Narrative* by Edward Tufte
4. *Beautiful Evidence* by Edward Tufte

## *The Visual Display of Quantitative Information* by Edward Tufte

### Summary

1. I sought to make this book self-exemplifying - that is, the physical object itself would reflect the intellectual principles advanced in the book. Publishers seemed appalled at the prospect that an author might govern design. So, I sought to self-publish...To finance the book, I took out another mortgage on my home. The bank officer said this was the second most unusual loan that she had ever made; first place belonged to a loan to a circus to buy an elephant!

### Key Takeaways

6. This is a book about the design of statistical graphics and, as such, it is concerned both with design and with statistics. But it is also about how to communicate information through the simultaneous presentation of words, numbers, and pictures. The design of statistical graphics is a universal matter - like mathematics - and is not tied to the unique features of a particular language.
7. Graphical Excellence
  1. Excellence in statistical graphics consists of complex ideas communicated with clarity, precision, and efficiency. Graphical displays should:
    1. show the data
    2. induce the viewer to think about the substance rather than about methodology, graphic design, the technology of graphic production, or something else
    3. avoid distorting what the data have to say
    4. present many numbers in a small space
    5. make large data sets coherent
    6. encourage the eye to compare different pieces of data
    7. reveal the data at several levels of detail, from a broad overview to the fine structure
    8. serve a reasonably clear purpose: description, exploration, tabulation, or decoration

9. be closely integrated with the statistical and verbal descriptions of a data set
  2. Excellence, nearly always of a multivariate sort, is illustrated here for fundamental graphic designs: data maps, time-series, space-time narrative purposes, providing a set of high-quality graphics that can be discussed in constructing a theory of data graphics
  3. Graphical excellence is the well-designed presentation of interesting data - a matter of substance, of statistics, of design
  4. Graphical excellence consists of complex ideas communicated with clarity, precision, and efficiency
  5. 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
8. Graphical Integrity
1. Graphical integrity is more likely to result if these 6 principles are followed:
    1. the representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented
    2. clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity. Write out explanations of the data on the graphic itself. Label important events in the data.
    3. show data variation, not design variation
    4. in time-series displays of money, deflated and standardized units of monetary measurement are nearly always better than nominal units
    5. the number of information-carrying (variable) dimensions depicted should not exceed the number of dimensions in the data
    6. graphics must not quote data out of context
9. Data-Ink and Graphical Redesign
1. Five principles in the theory of data graphics produce substantial changes in graphical design. The principles apply to many graphics and yield a series of design options through cycles of graphical revision and editing
    1. Above all else, show the data
    2. Maximize the data-ink ratio
    3. Erase non-data-ink
    4. Erase redundant data-ink
    5. Revise and edit

## 10. Theory of Data Graphics

1. Forgo chartjunk, including moire vibration, the grid (use gray grids), and the duck
2. Well-designed small multiples are:
  1. inevitably comparative
  2. deftly multivariate
  3. shrunken, high-density graphics
  4. usually based on a large data matrix
  5. drawn almost entirely with data-ink
  6. efficient in interpretation
  7. often narrative in content, showing shifts in the relationship between variables as the index variable changes (thereby revealing interaction of multiplicative effects)
3. Small multiples reflect much of the theory of data graphics:
  1. for non-data-ink, less is more
  2. for data-ink, less is a bore

## 11. Aesthetics and Technique in Data Graphics Design

1. Graphical elegance is often found in simplicity of design and complexity of data
2. Attractive displays of statistical information:
  1. have a properly chosen format and design
  2. use words, numbers, and drawings together
  3. reflect a balance, a proportion, a sense of relevant scale
  4. display an accessible complexity of detail
  5. often have a narrative quality, a story to tell about the data
  6. are drawn in a professional manner, with the technical details of production done with care
  7. avoid content-free decoration, including chartjunk

## 12. Epilogue

1. Design is choice. The theory of the visual display of quantitative information consists of principles that generate design options and that guide choices among options. The principles should not be applied rigidly or in a peevish spirit; they are not logically or mathematically certain; and it is better to violate any principle than to place graceless or inelegant marks on paper. Most principles of design should be greeted with some skepticism, for word authority can dominate our vision, and we may come to see only through the lenses of word authority rather

than with our own eyes. What is to be sought in designs for the display of information is the clear portrayal of complexity. Not the complication of the simple; rather the task of the designer is to give visual access to the subtle and the difficult - that is, the revelation of the complex.

What I got out of it

1. Some of the deeper philosophy on what makes effective design and presentations

## *Envisioning Information* by Edward Tufte

### Summary

1. 6 core principles are described in how to best display data visualizations

### Key Takeaways

#### 1. Escaping Flatland

1. Visual displays of information encourage a diversity of individual viewer styles and rates of editing, personalizing, reasoning, and understanding. Unlike speech, visual displays are simultaneously a wideband and perceiver-controllable channel
2. If the numbers are boring, you've got the wrong numbers. Credibility vanishes in clouds of chartjunk; who would trust a chart that looks like a video game?
3. Worse is contempt for our audience, designing as if readers were obtuse and uncaring. Clarity and simplicity are completely opposite simple-mindedness

#### 2. Micro/Macro Readings

1. A most unconventional design strategy is revealed: to clarify, add detail. Clutter and confusion are failures of design, not attributes of information. What we seek is not necessarily simplicity, but an understanding of complexity revealed with an economy of means
  1. *Note: Shows some high-level maps which become clearer as details such as trees, street names, and more are added*
2. John Tukey - if we are going to make a mark, it may as well be a meaningful one. The simplest - and most meaningful mark is a digit
3. Visual displays rich with data are not only an appropriate and proper complement to human capabilities, but also such designs are frequently optimal. Micro/Macro designs enforce both local and global comparisons and, at the same time, avoid the disruption of context switching. All told, exactly what is needed is for reasoning about information
4. It is not how much information there is, but rather how effectively is it arranged. Showing complexity often demands hard, thoughtful work. Detailed micro/macro designs have substantial costs for data collection, design, custom computing, image processing, and production - expenses similar to that of first-class cartography.

### 3. Layering and Separation

1. Tables without vertical rules look better; thin rules are better than thick ones

### 4. Small Multiples

1. At the heart of quantitative reasoning is a single question: compared to what? Small multiple designs, multivariate and data bountiful answer directly by visually enforcing comparisons of changes, of the differences among objects, of the scope of alternatives. For a wide range of problems in data presentation, small multiples are the best design solution.
2. Comparisons must be enforced within the scope of the eye span, a fundamental point occasionally forgotten in practice

### 5. Color and Information

1. While the eyes are extremely sensitive to color variations, anything more than 20 or 30 colors frequently produce not diminishing but negative returns. Above all, do no harm

### 6. Narratives of Space and Time

1. Many information displays report on the world's workaday reality of three-space and time. Painting four-variable narrations of space-time onto flatland combines two familiar designs, the map and the time-series. Our strategy for understanding these narrative graphics is to hold constant the underlying information and then to watch how various designs and designers cope with the common data. Examined first are accounts of the motion of Jupiter's satellites, beginning with Galileo's notebooks. Other case studies in our space-time tour are itinerary designs (schedules and route maps) and, finally, various notational systems for describing and preserving dance movements.

### What I got out of it

1. Some of the more technical reasons for what makes a great diagram/visual



*Visual Explanations: Images and Quantities, Evidence and Narrative* by Edward Tufte

### Summary

1. This book describes design strategies - the proper arrangement in space and time of images, words, and numbers - for presenting information about motion, process, mechanism, cause and effect. These strategies are found again and again in portrayals of explanations, quite independent of the particular substantive content or technology of display.

### Key Takeaways

1. The first part of this book examines the logic of depicting quantitative evidence. What principles should inform our designs for showing data? Where do those principles come from? How can the integrity of quantitative descriptions be maintained in the face of complex and animated representations of data? What are the standards for evaluating visual evidence, especially for making decisions and reaching conclusions? The second part considers design strategies, often for the arrangement of images as narrative. Here the issues are more visual - and lyrical - than quantitative. The idea is to make designs that enhance the richness, complexity, resolution, dimensionality, and clarity of the content. By extending the visual capacities of paper, video, and computer screen, we are able to extend the depth of our own knowledge and experience. And so, this part of the book reports on architectures of comparison and narrative: parallelism, multiples, and confections
2. **Those who discover an explanation are often those who construct its representation**
  1. *Hologram in the head, [Wozniak designing both the hardware and the software - no bugs ever found](#)*
3. **Many of our examples suggest that clarity and excellence in thinking is very much like clarity and excellence in the display of data. When principles of design replicate principles of thought, the act of arranging information becomes an act of insight**
4. My 3 books on information design stand in the following relation:
  1. The Visual Display of Quantitative Information is about pictures of numbers, how to depict data and enforce statistical honesty

2. Envisioning Information is about pictures of nouns (maps and aerial photographs, for example, consist of a great many nouns lying on the ground). Envisioning also deals with visual strategies for design: color, layering, and interaction effects
3. Visual Explanations is about pictures of verbs, the representation of mechanism and motion, of process and dynamics, of causes and effects, of explanation and narrative. Since such displays are often used to reach conclusions and make decisions, there is a special concern with the integrity of the content and the design
4. These books are meant to be self-exemplifying: the objects themselves embody the ideas written about. Enchanted by the elegant and precise beauty of the best displays of information, and also inspired by the idea of self-exemplification, I have come to write, design, and publish the 3 books myself.
  1. *Gödel and recursion*
5. Clear logic of data display and analysis includes:
  1. Placing the data in an appropriate context for assessing cause and effect
  2. Making quantitative comparisons. The deep, fundamental question in statistical analysis is *compared to what?* Therefore, investigating the experiences of the victims of cholera as Snow did is only part of the search for credible evidence; to understand fully the cause of the epidemic also requires an analysis of those who *escaped* the disease. With great clarity, the map presented several intriguing clues for comparisons between the living and the dead, clues strikingly visible at a brewery and workhouse...
  3. Considering alternative explanations and contrary cases. Sometimes it can be difficult for researchers - who both report and advocate their findings - to face up to threats to their conclusions, such as alternative explanations and contrary cases. Nonetheless, the credibility of a report is enhanced by a careful assessment of *all* relevant evidence, not just evidence overtly consistent with explanations advanced by the report. The point is to get it right, not to win the case, not to sweep under the rug all the assorted puzzles and inconsistencies that frequently occur in collections of data
  4. Assessment of possible errors in the numbers reported in the graphics. Snow's analysis attends to the sources and consequences of errors in gathering the data. In particular, the credibility of the cholera map grows out of supplemental details in the text - as image, word, and number combine to present the evidence and make the argument. Detailed comments on possible errors annotate both the map

and the table, reassuring readers about the care and integrity of the statistical detective work that produced the data graphics

1. Enough exploration must be done so that the results are shown to be relatively insensitive to plausible alternative specifications and data choices. Only in that way can the statistician protect himself or herself from the temptation to favor the client and from the ensuing cross-examination. - John Tukey
6. Numbers become evidence by being in relation to
7. Chartjunk - good design brings absolute attention to data
8. Jonson's Principle - these problems are more than just poor design, for a lack of visual clarity in arranging evidence is a sign of a lack of intellectual clarity in reasoning about evidence.
9. Visual representations of evidence should be governed by principles of reasoning about quantitative evidence. For information displays, design reasoning must correspond to scientific reasoning. Clear and precise seeing becomes as one with clear and precise thinking.
10. To document and explain a process, to make verbs visible, is at the heart of information design
11. Presenting Techniques
  1. These techniques of disinformation design [magic], when reversed, reinforce strategies of presentation used by good teachers. Your audience should know beforehand what you are going to do; then they can evaluate how your verbal and visual evidence supports your argument. And so, we have some practical advice for giving a talk or paper:
    1. Near the beginning of your presentation, tell the audience: what the problem is, why the problem is important, what the solution to the problem is.
    2. If a clear statement of the problem cannot be formulated, then that is a sure sign that the content of the presentation is deficient. Repeated variations on the same idea will often clarify and develop an idea.
  2. To explain complex ideas, use the method of PGP: Particular - General - Particular
    1. Seek to maximize the rate of information transfer to your audience. Yet many presentations rely on low-resolution devices to communicate information - reading aloud from images projected up on the wall from

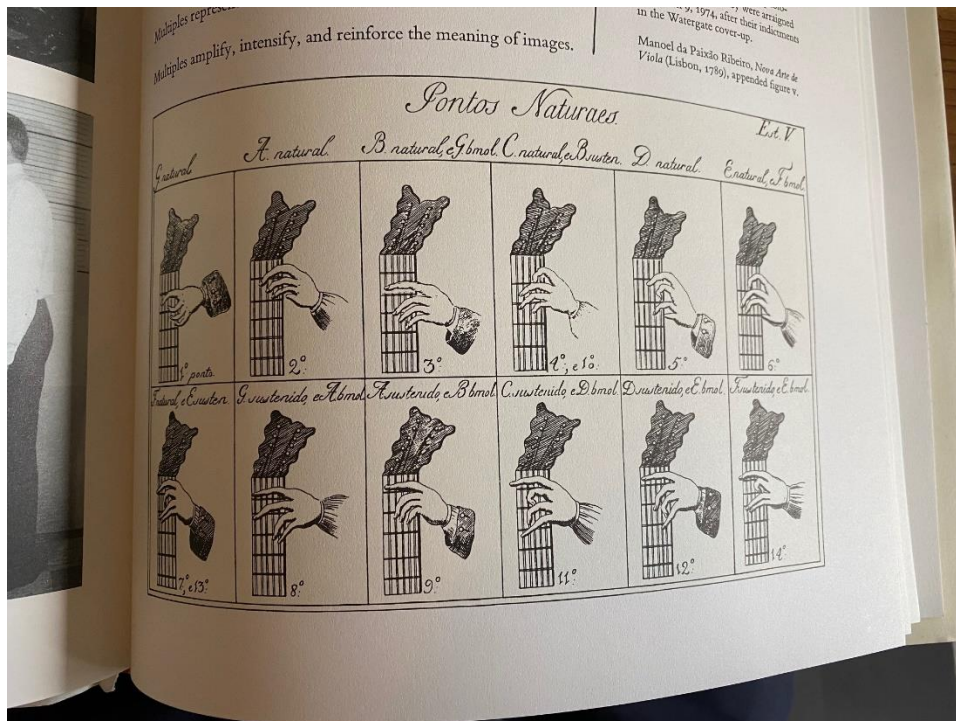
computer screens or from the dreaded overhead projector or talk, talk, talk. Instead, try a high-resolution method: No matter what, give everybody in the audience one or more pieces of paper, packed with material related to your presentation. Handouts show pictures, diagrams, data tables, research methods, references, names of people at the meeting, or the complete text of the paper outlined in your talk. Unlike evanescent projected images, permanent and portable paper has credibility. Paper serves as a testimonial record documenting your talk, letting your audience know that you take responsibility for what you say. People can file your handouts away and then come back in a month and ask, "Didn't you say this?"

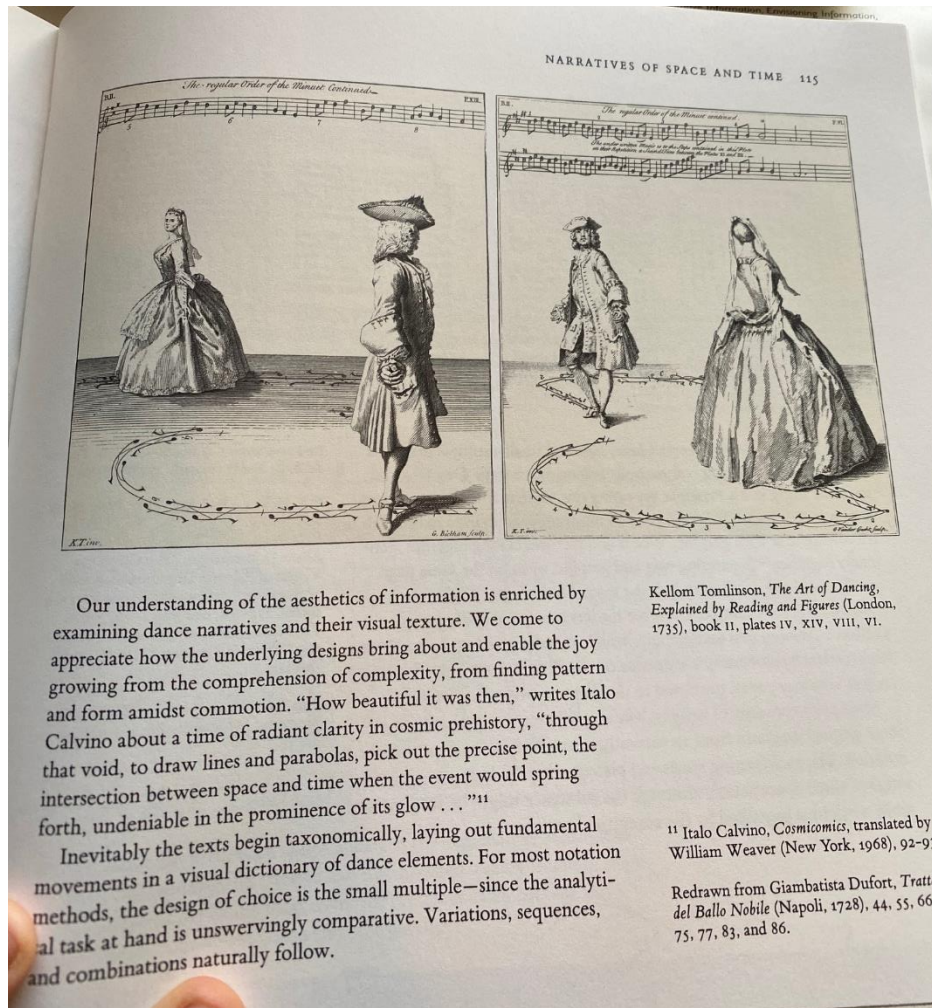
3. Analyze the details of your presentation; then master those details by practice, practice, practice
  4. Show up early. Something good is bound to happen
  5. Finish early
12. Questions to ask about your data/presentation
1. Is the display revealing the truth?
  2. Is the representation accurate?
  3. Are the data carefully documented?
  4. Do the methods of display avoid spurious readings of the data?
  5. Are appropriate comparisons and contexts shown?
13. The smallest effective difference
1. Make all visual distinctions as subtle as possible, but still clear and effective. Relevant to nearly every display of data, the smallest effective difference is the Occam's razor ("what can be done with fewer is done in vain with more") of information design. And often the happy consequence of an economy of means is a graceful richness of information, for small differences allow more differences.
  2. Minimal distinctions reduce visual clutter. small contrasts work to enrich the overall visual signal by increasing the number of distinctions that can be made within a single image; thus, design by means of small effective differences helps to increase the resolution of our images.
14. Parallelism
1. Embodying inherent links and connections, parallelism synchronizes multiple channels of information, draws analogies, enforces contrasts and comparisons. Our examples have inventoried all sorts of design strategies that collate like with

like: pairing, orientation, simultaneity, overlap, superimposition, flowing together on a common track, codes, pointer lines, sequence, adjacency, analogy, similar content. Parallelism provides a coherent architecture for organizing and learning from images - as well as from words and numbers, the allies of images. And by establishing a structure of rhythms and relationships, parallelism becomes the poetry of visual information.

### 15. Multiples in space and time

1. Multiple images reveal repetition and change, pattern and surprise - the defining elements in the idea of information. Multiples directly depict comparisons, the essence of statistical thinking. Multiples enhance the dimensionality of the flatlands of paper and computer screen, giving depth to vision by arraying panels and slices of information. Multiples create visual lists of objects and activities, nouns and verbs, helping viewers to analyze, compare, differentiate, decide - as we see below with 12 hands in 12 positions for making 12 sounds. Multiples represent and narrate sequences of motion. Multiples amplify, intensify, and reinforce the meaning of images.





Our understanding of the aesthetics of information is enriched by examining dance narratives and their visual texture. We come to appreciate how the underlying designs bring about and enable the joy growing from the comprehension of complexity, from finding pattern and form amidst commotion. "How beautiful it was then," writes Italo Calvino about a time of radiant clarity in cosmic prehistory, "through that void, to draw lines and parabolas, pick out the precise point, the intersection between space and time when the event would spring forth, undeniable in the prominence of its glow . . ."<sup>11</sup>

Inevitably the texts begin taxonomically, laying out fundamental movements in a visual dictionary of dance elements. For most notation methods, the design of choice is the small multiple—since the analytical task at hand is unswervingly comparative. Variations, sequences, and combinations naturally follow.

Kellom Tomlinson, *The Art of Dancing, Explained by Reading and Figures* (London, 1735), book II, plates IV, XIV, VIII, VI.

<sup>11</sup> Italo Calvino, *Cosmicomics*, translated by William Weaver (New York, 1968), 92–93.

Redrawn from Giambattista Dufort, *Trattato del Ballo Nobile* (Napoli, 1728), 44, 55, 66, 75, 77, 83, and 86.

2. Multiples help to monitor and analyze multi-variable processes - ordinary occurrences in medicine, finance, quality control, and large-scale industrial and engineering operations. By providing a quick, simultaneous look at a continuing flow of different measurements, multiples help sort out the relevant substance from a flood of numbers.

### What I got out of it

1. Another beautiful book by Tufte with some great advice on how to present quantitative evidence.

## *Beautiful Evidence* by Edward Tufte

### Summary

1. Evidence that bears on questions of any complexity typically involves multiple forms of discourse. Evidence is evidence, whether words, numbers, images, diagrams, still, or moving. The intellectual task remain constant regardless of the mode of evidence: to understand and to reason about the materials at hand, and to appraise their quality, relevance, and integrity. Science and art have in common *intense seeing*, the wide-eyed observing that generates empirical information. *Beautiful Evidence* is about *how seeing turns into showing*, how empirical observations turn into explanations and evidence. The book identifies excellent and effective methods for showing evidence, suggests new designs, and provides analytical tools for assessing the credibility of evidence presentations. Evidence presentations are seen here from both sides: how to *produce* them and how to *consume* them. As teachers know, a good way to learn something is to teach it. The partial symmetry of producers and consumers is a consequence of the theory of analytical design, which is based on the premise that *the point of evidence displays is to assist the thinking of producer and consumer alike*. Evidence presentations should be created in accord with the common analytical tasks at hand, which usually involve understanding causality, making multivariate comparisons, examining relevant evidence, and assessing the credibility of evidence and conclusions. Thus, the principles of evidence display are derived from the universal principles of analytical thinking - and not from local customs, intellectual fashions, consumer convenience, marketing, or what the technologies of display happen to make available. The metaphor for evidence presentations is analytical thinking.

### Key Takeaways

7. The images and diagrams in this book reward careful study. Many are excellent treasures, complex and witty, intense with meaning.
  1. Note: [This book is beautiful](#) and probably worth getting just for the images and understanding what it takes to make a deeply meaningful image/diagram
8. My books are self-exemplifying: the objects themselves embody the ideas written about. This has come about, in part, because my work is blessedly free of clients, patronage, or employers

9. The principles of analytical thinking (and thus analytical design) are universal - like mathematics, the laws of Nature, the deep structure of language - and are not tied to any language, culture, style, century, gender, or technology of information display.
10. Explanatory, journalistic, and scientific images should nearly always be mapped, contextualized, and placed on the universal grid. *Mapped pictures* combine representational images with scales, diagrams, overlays, numbers, words, images. Good mappings of realistic images have been produced throughout the long history of visual displays, but not often enough. An explanatory image is an explanatory image because it is a *mapped* image. Sensibly mapped pictures nearly always outperform purely pictorial representations for representing, explaining, and documenting evidence.
11. Sparklines are datawords: data-intense, design-simple, word-sized graphics.
12. Multiple sources and levels of data - use whatever evidence it takes to understand what is going on. Too often diagrams instead rely solely on one type of data or stay at one level of analysis
13. Efficiency of design - the design should be straightforward with no unnecessary elements. Designs for analytical diagrams should be clear, efficient, undecorated, maplike. The metaphor is the map, not stupidity. Omitting boxes increases explanatory resolution
14. The similar treatment of text, diagrams, and images suggests to readers that images are as relevant and credible as words and diagrams. A book design that treats all modes of information alike reinforces the point.
15. All in one head - Megan Jaegerman did both the research and the design, breaking their common alienation. This design amplifies the content, because the designer created the content
16. Charles Joseph Minard's data-map showing Napoleon's invasion and retreat of Russia may be one of the best designed diagrams of all-time
  1. Principle 1: Comparisons - show comparisons, contrasts, differences
  2. Principle 2: Causality, mechanisms, structure, explanation - show causality, mechanism, explanation, systemic structure
  3. Principle 3: Multivariate Analysis - show multivariate data; show more than 1 or 2 variables
  4. Principle 4: Integration of Evidence - completely integrate words, numbers, diagrams



5. Principle 5: Documentation - thoroughly describe the evidence. Provide a detailed title, indicate the authors and sponsors, document the data sources, show complete measurement scales, point out relevant issues.
6. Principle 6: Content counts most of all - analytical representations ultimately stand or fall depending on the quality, relevance, and integrity of their content
17. Making a presentation is a moral act as well as an intellectual activity
18. A clear sign of cherry-picking is that a report appears too good to be true, provoking consumers of the report to mutter, "It's more complicated than that." Avoid overreaching, slippery language, stupendous conclusions
19. PowerPoint is a competent slide manager, but it should not impose its cognitive style on our presentations. Instead of showing a few informal talking points on a slide, why not print out an agenda for everyone?
20. For serious presentations, replace PP with word-processing or page-layout software. Making the transition in large organizations requires a straightforward executive order: from now on your presentation software is Microsoft Word, not PP. Get used to it
21. At a talk, paper handouts of technical reports effectively show text, data graphics, images. Printed materials bring information transfer rates in presentations up to that of everyday material in newspapers, reports, books, and internet news sites. An excellent paper size is 11x17 inches, folded in half to make 4 pages. That one piece of paper can show the content-equivalent of 50 to 250 typical PP slides. Serious presentations might begin by handing out this paper and having the group read it. Following the reading period, the presenter might provide a guided analysis of the briefing paper and then encourage and perhaps lead a discussion of the material at hand.

#### What I got out of it

1. A beautiful book which helped me better understand what an effective presentation and diagram looks like and some of the core mistakes to avoid. Incorporating and integrating words, images, graphs, and anything else which helps the reader more easily understand is the key.

