Data Visualisation

Graphical Excellence

largely from Edward Tufte,
The Visual Display of Quantitative Information, Graphics Press, 1983.

A Key Question

How do we

Convert abstract information into a visual representation

While still preserving the underlying meaning

And at the same time providing new insight?

E. Tufte: Visual Display of Quantitative Information

Tufte's Graphical Theory and Guidelines

- Show the data
- Induce viewer to think about the substance
- Avoid distorting the data
- Present many numbers in a small space
- Make large data sets coherent
- Encourage visual comparisons
- Reveal data at several levels of details
- Serve a clear purpose (description, explanation, tabulation, decoration)
- Integrate closely with text descriptions

Graphical Excellence

Fundamental graphic designs include:

- Data maps: these involve placement of additional information spatially situated on a spatially explicit diagram.
- Time series: these involve plotting some data as it changes across time.
- Space-time narrative: plotting changes across both space and time.
- Relational graphics: designed to show the relationship between two or more data aspects.

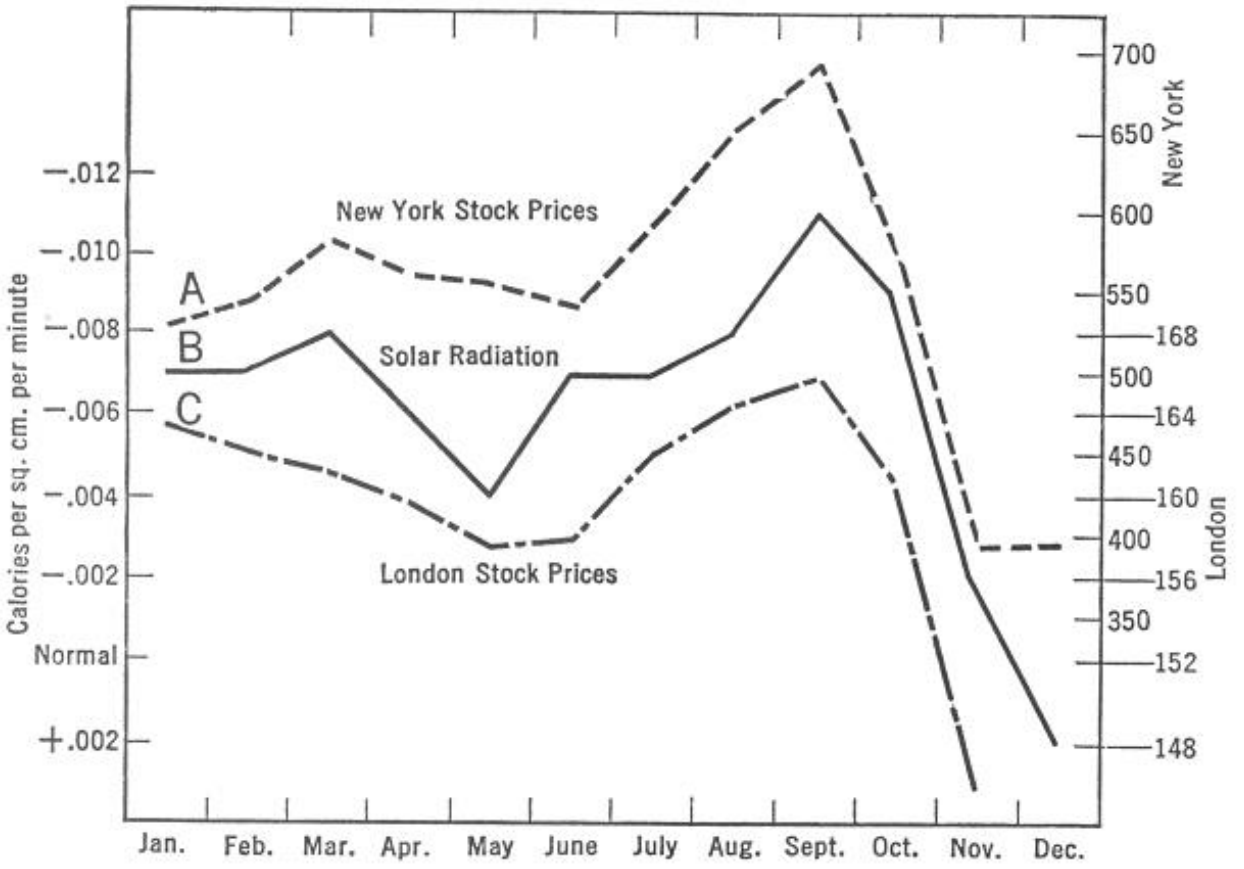
E. Tufte: Visual Display of Quantitative Information

Graphical Excellence

Start with reasonable data

A. New York stock prices
B. Solar radiation inverted,
C. London stock prices

For all months 1929



SOLAR RADIATION AND STOCK PRICES

E. Tufte: Visual Display of Quantitative Information

Data Maps

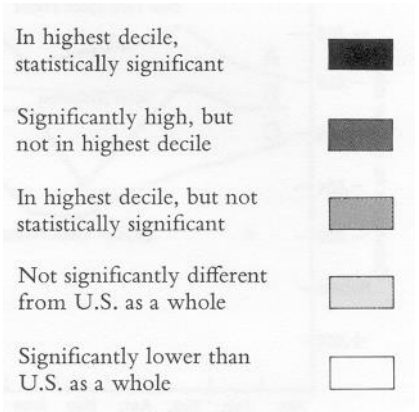
Age-adjusted death rates by cancer type for USA

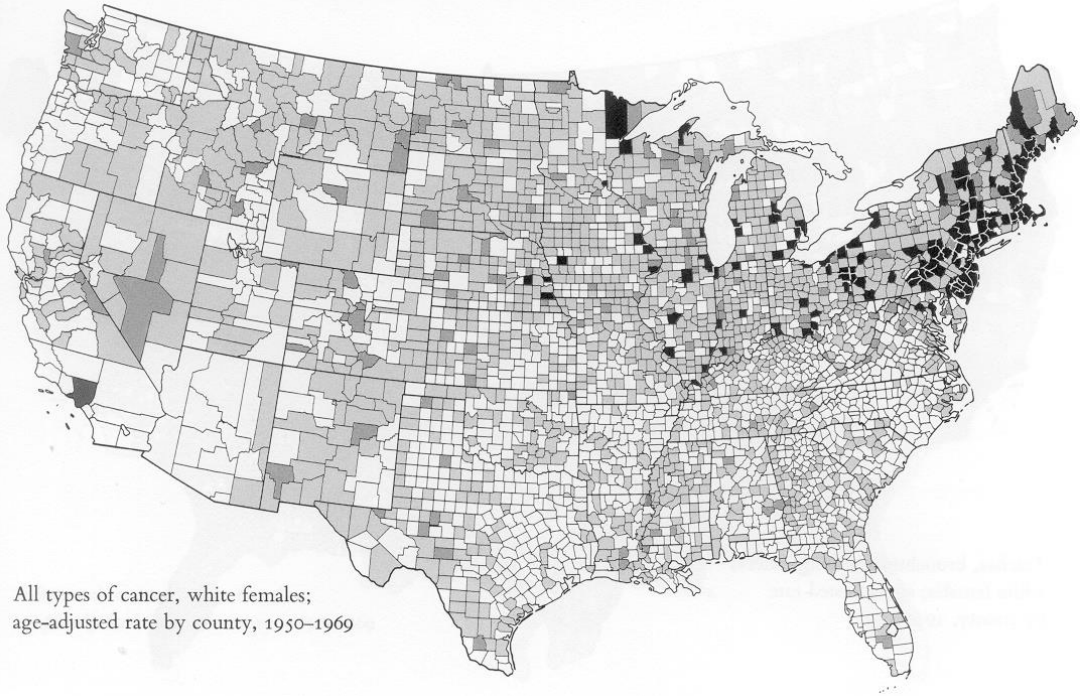
(each some 21,000 numbers)

Can be considered at many levels from overall pattern to county by county detail

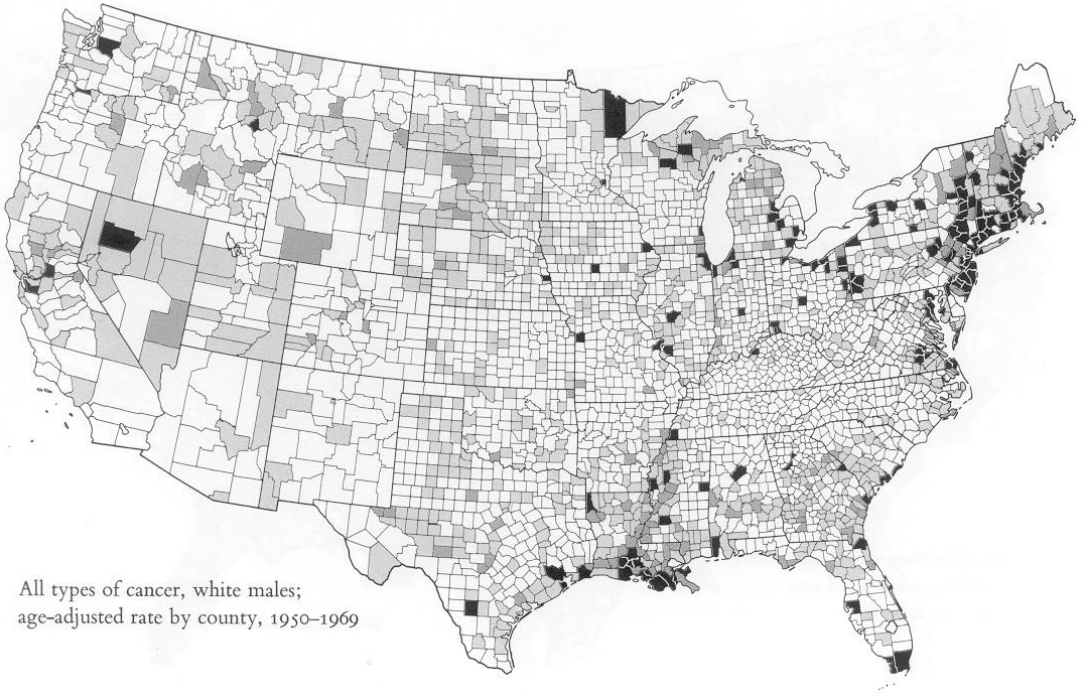
- High death rates in north east and around great lakes
- Low rates in band down middle
- Higher rates for men than women in south
- Hot spots; in Minnesota, Iowa, Nebraska, along the Missouri River
- Differences in cancer types by regions

Atlas of Cancer Mortality in the U.S., 1950-94 (Book)
http://www3.cancer.gov/atlasplus/index.html





All types of cancer, white females; age-adjusted rate by county, 1950–1969



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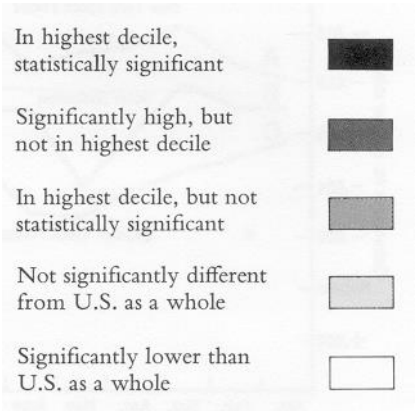
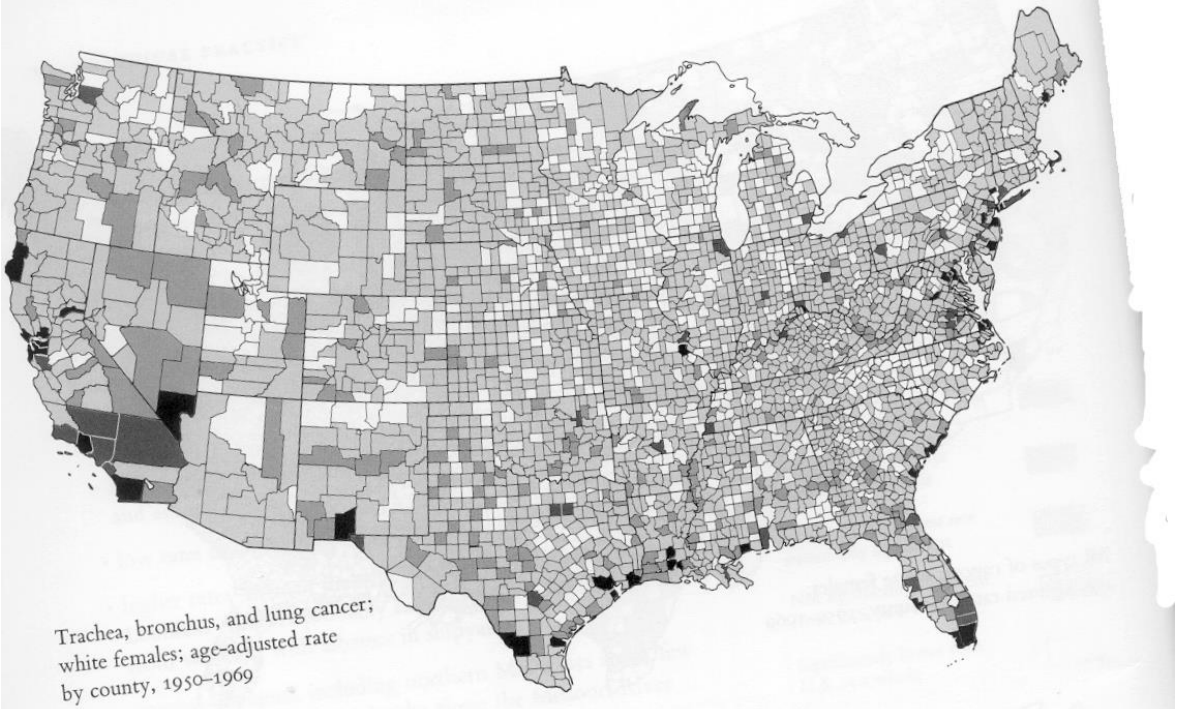
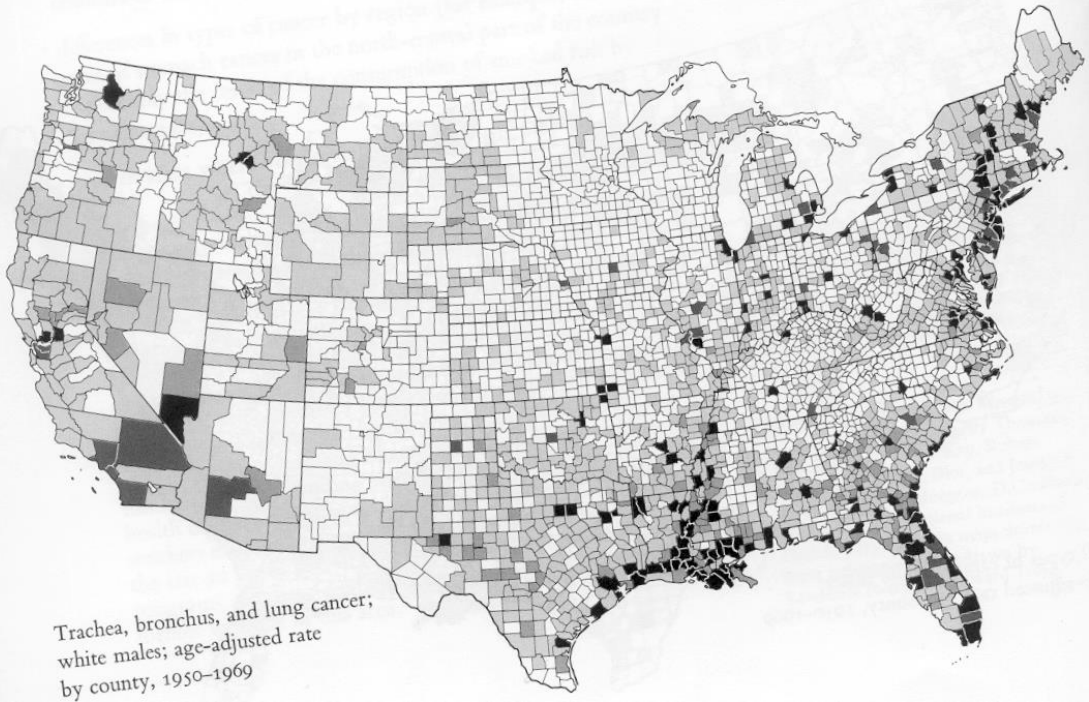
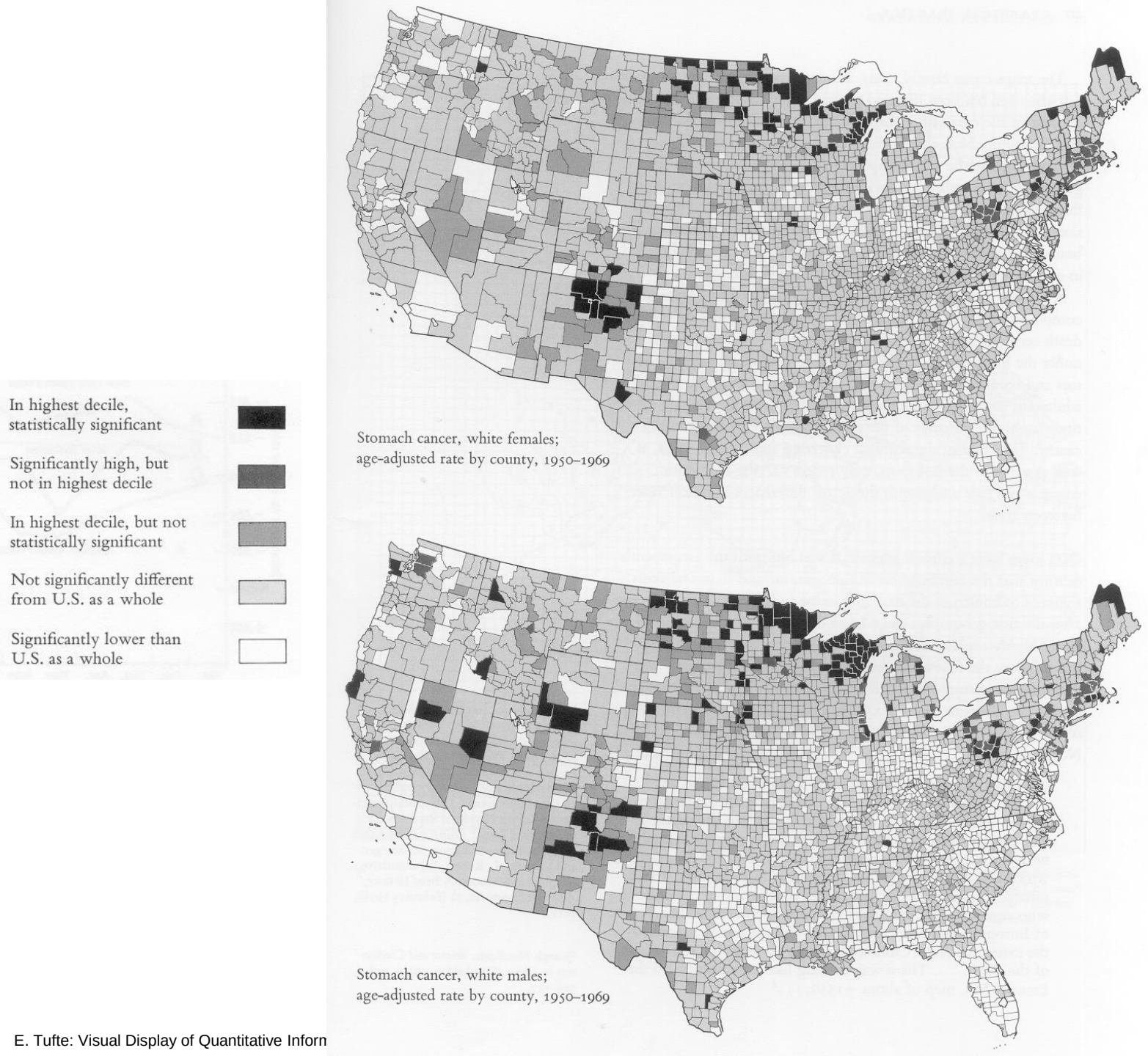




Trachea, bronchus, and lung cancer; white females; age-adjusted rate by county, 1950–1969



Trachea, bronchus, and lung cancer; white males; age-adjusted rate by county, 1950–1969


In highest decile, statistically significant
Significantly high, but not in highest decile
In highest decile, but not statistically significant
Not significantly different from U.S. as a whole
Significantly lower than U.S. as a whole
Stomach cancer, white females; age-adjusted rate by county, 1950–1969
Stomach cancer, white males; age-adjusted rate by county, 1950–1969

Data Map

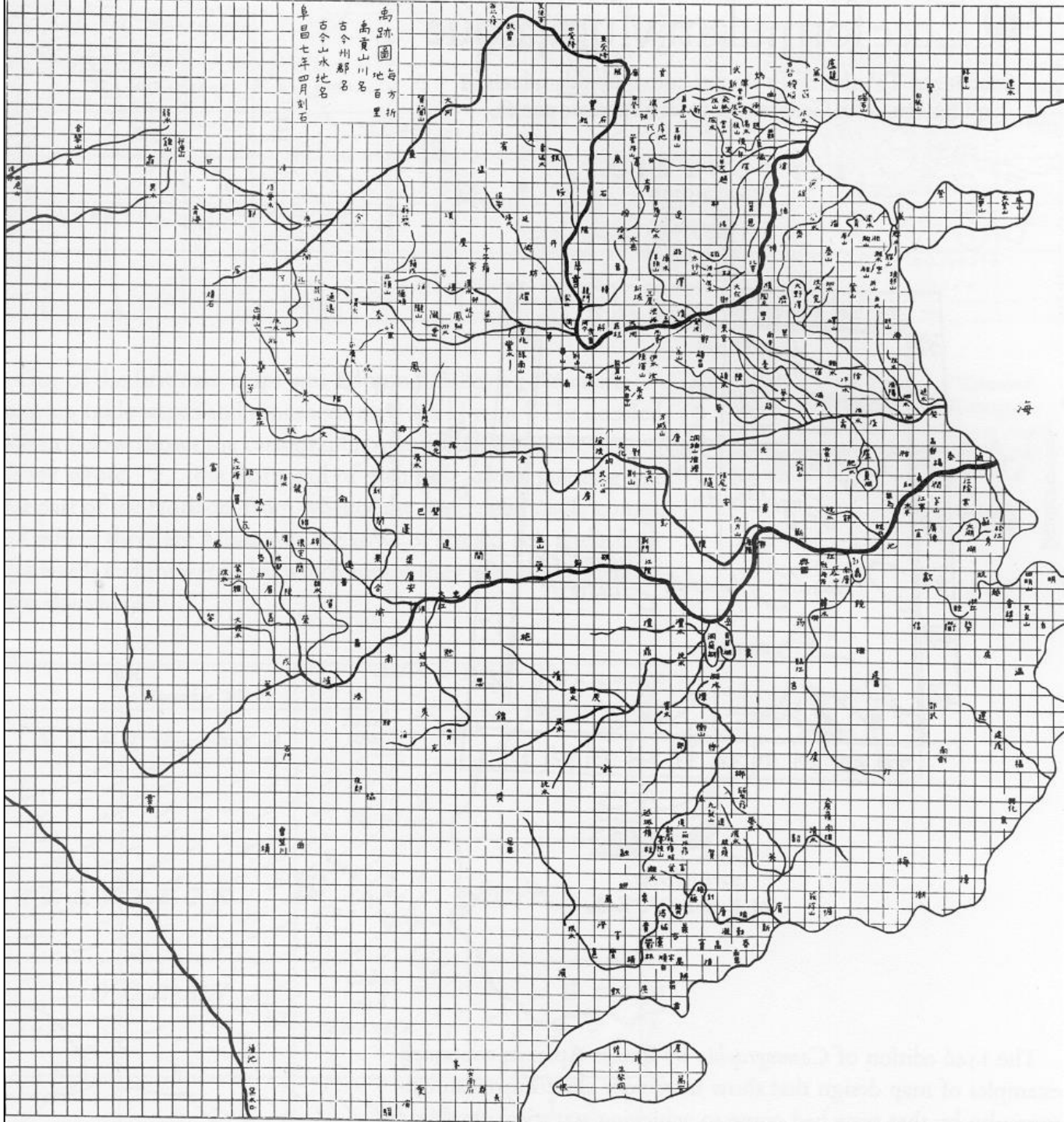
Grid map - Carved in stone in China

1137 – probably created 1100

Precision of coast and rivers remarkable

About 3 feet square

Nothing like it in Europe until the 1500s



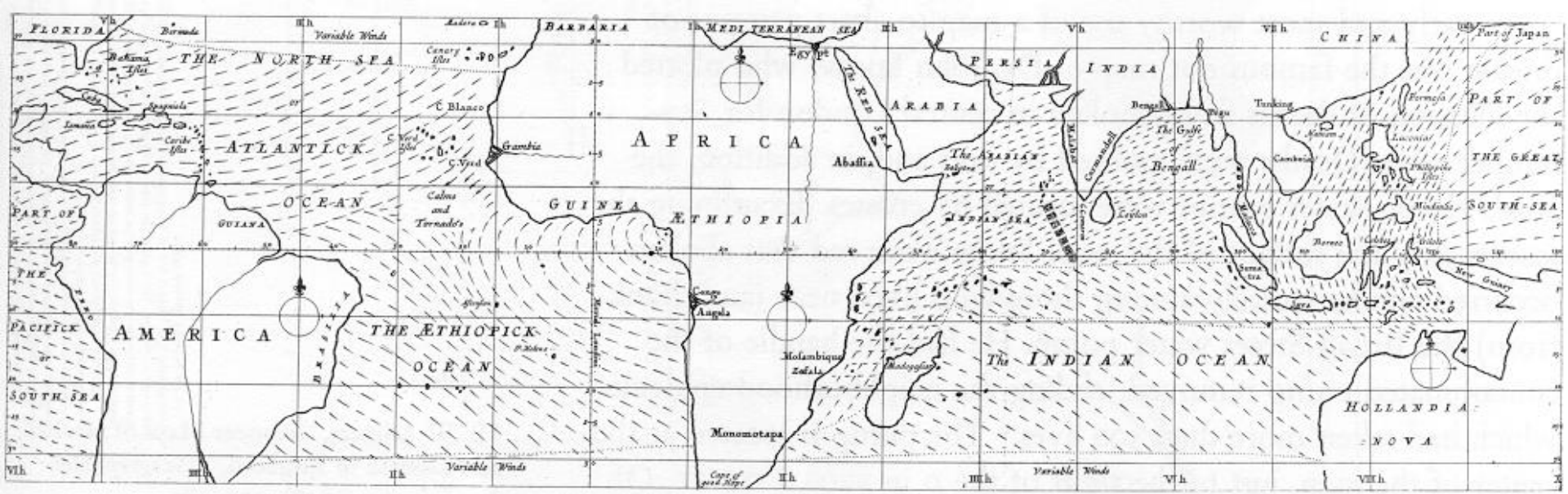
E. Chavannes, “Les Deux Plus Anciens Specimens de la Cartographic Chinoise,” Bulletin de l’ Ecole Française se l’ Extreme Orient, 3 (1903), 1-13, Carte B.

E. Tufte: Visual Display of Quantitative Information

Data Maps

1st data maps

Edmond Halley's 1686 map shows trade winds and monsoons

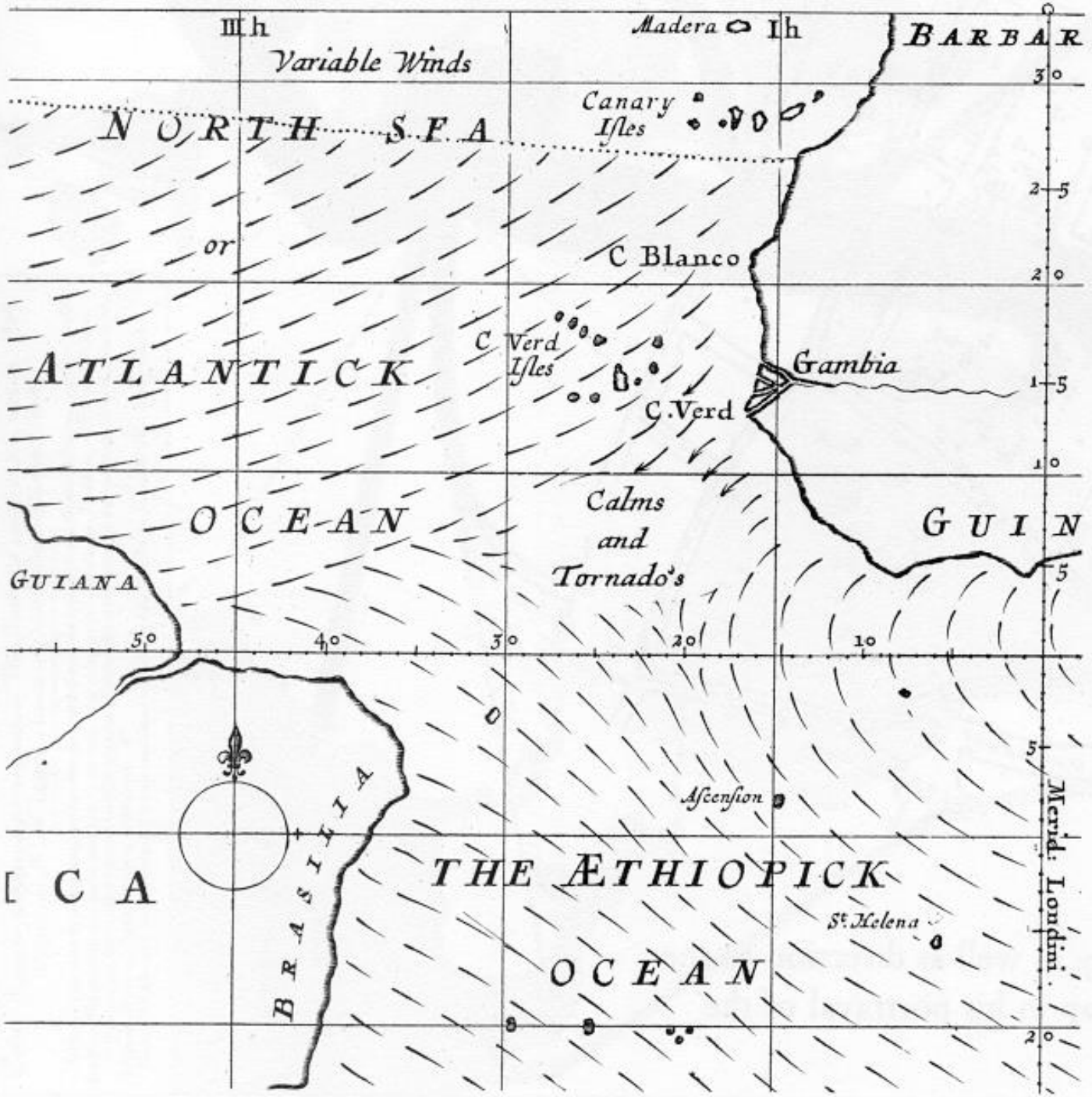


Norman J. W. Thrower, "Edmond Halley as a thematic Geo-Cartographer," Annals of the association of American Geographers, 59 (Dec. 1969), p 652-676 (Tufte, 1883, p.23)

Data Maps

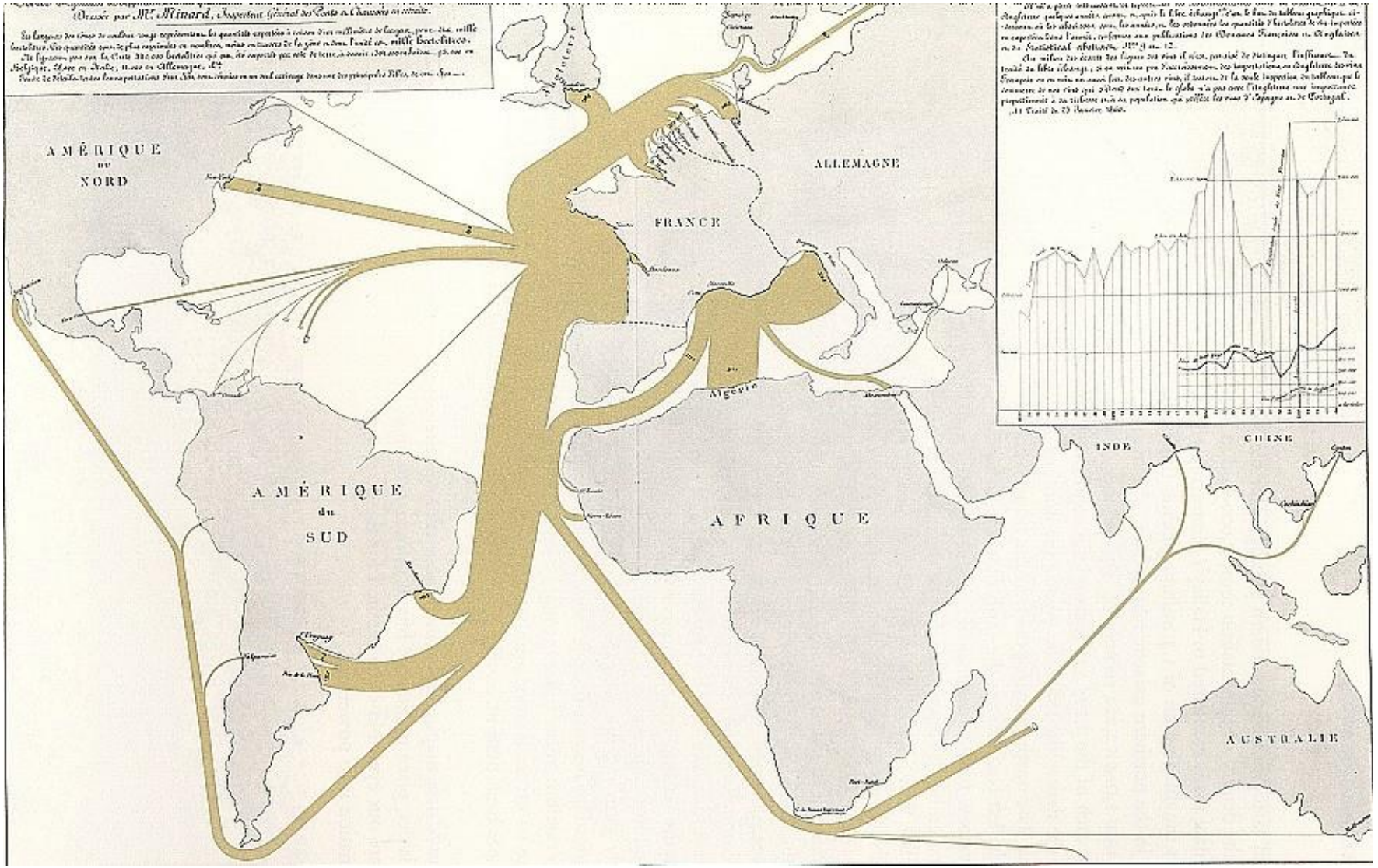
1686

Detail of trade winds map shows encoding – “the sharp end of each little stroke pointing out … from whence the wind continually comes



Edmond Halley, “An Historical Account of the Trade Winds, and Monsoons, Observable in the Seas Between and Near the Tropicks; With an Attempt to Assign the Phisical Cause of Said Winds,” Philosophical Transactions, 183 (1686), p. 153-168 (Tufte, 1883, p.23)

Data map: 1864 Exports of French Wine

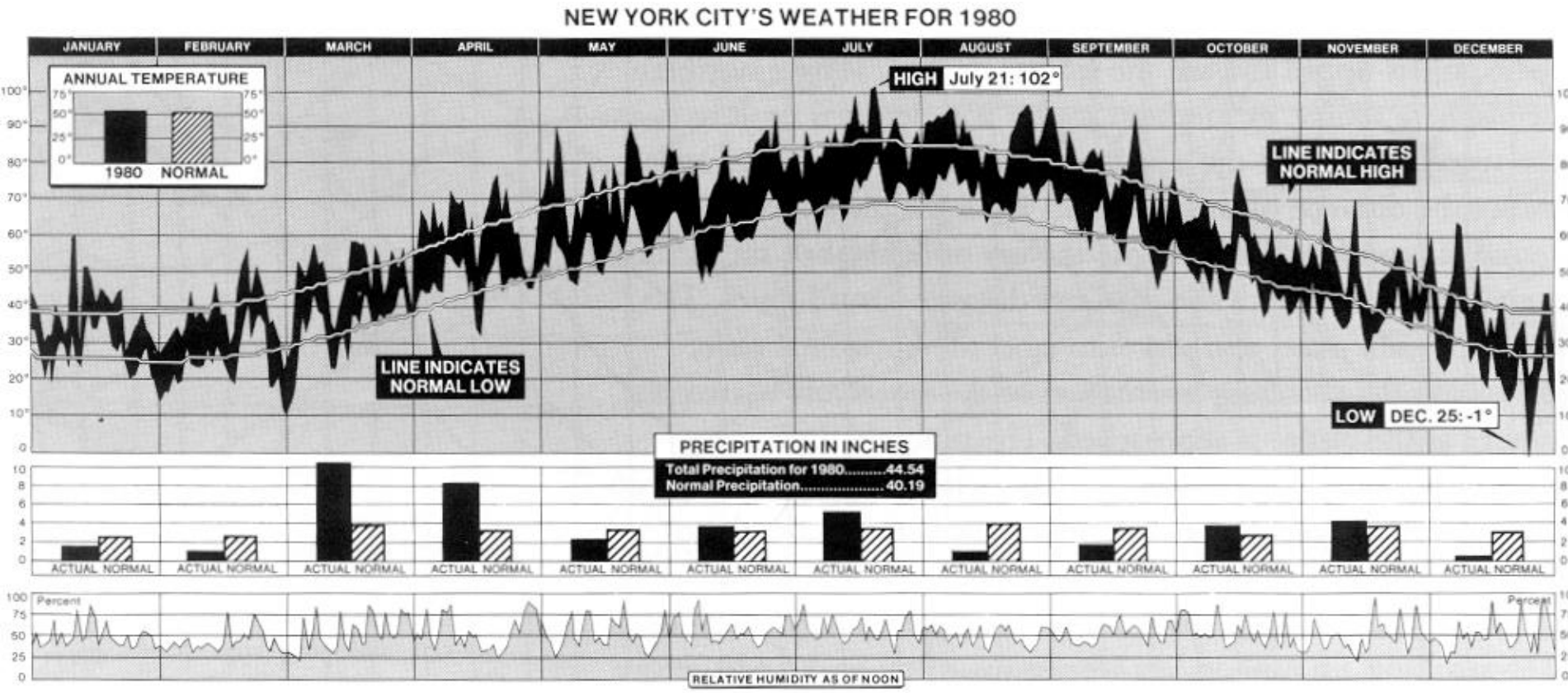


E. Tufte "Visual Display of Quantitative Information" p 25,

Time Series

New York Weather History- 1980

- Data density - 181 numbers/sq inch



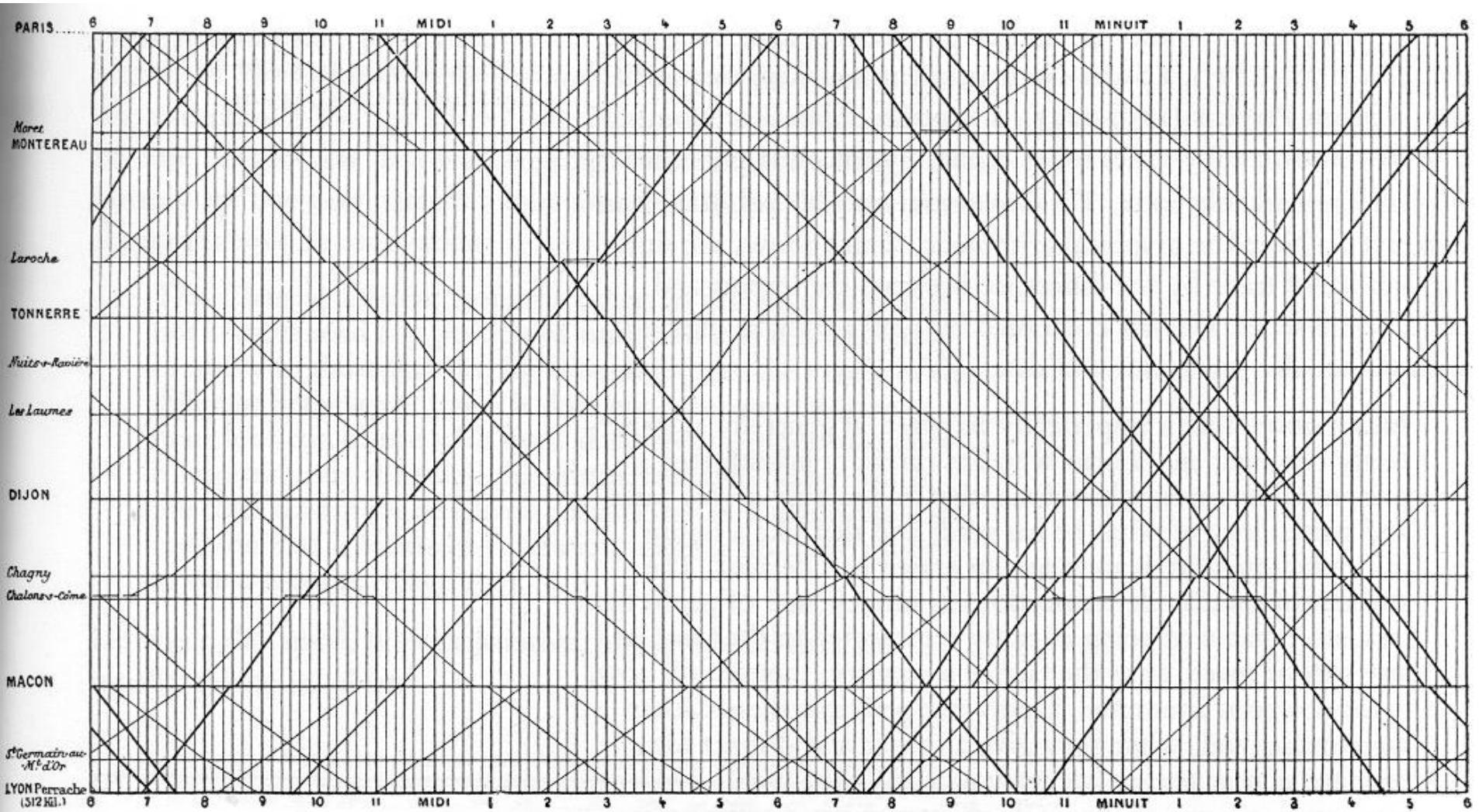
New York Times, (Jan. 1981), p.32, (Tufte, 1883, p.30)

E.J. Marey, "La Methode Graphique," (Paris 1885), p.20. This method is attributed to the french engineer, Irby (Tufte, 1883, p.31)

Time Series

E. J. Marey. 1885. Train schedules from Paris to Lyon

Stations spaced according to distances, time from left to right



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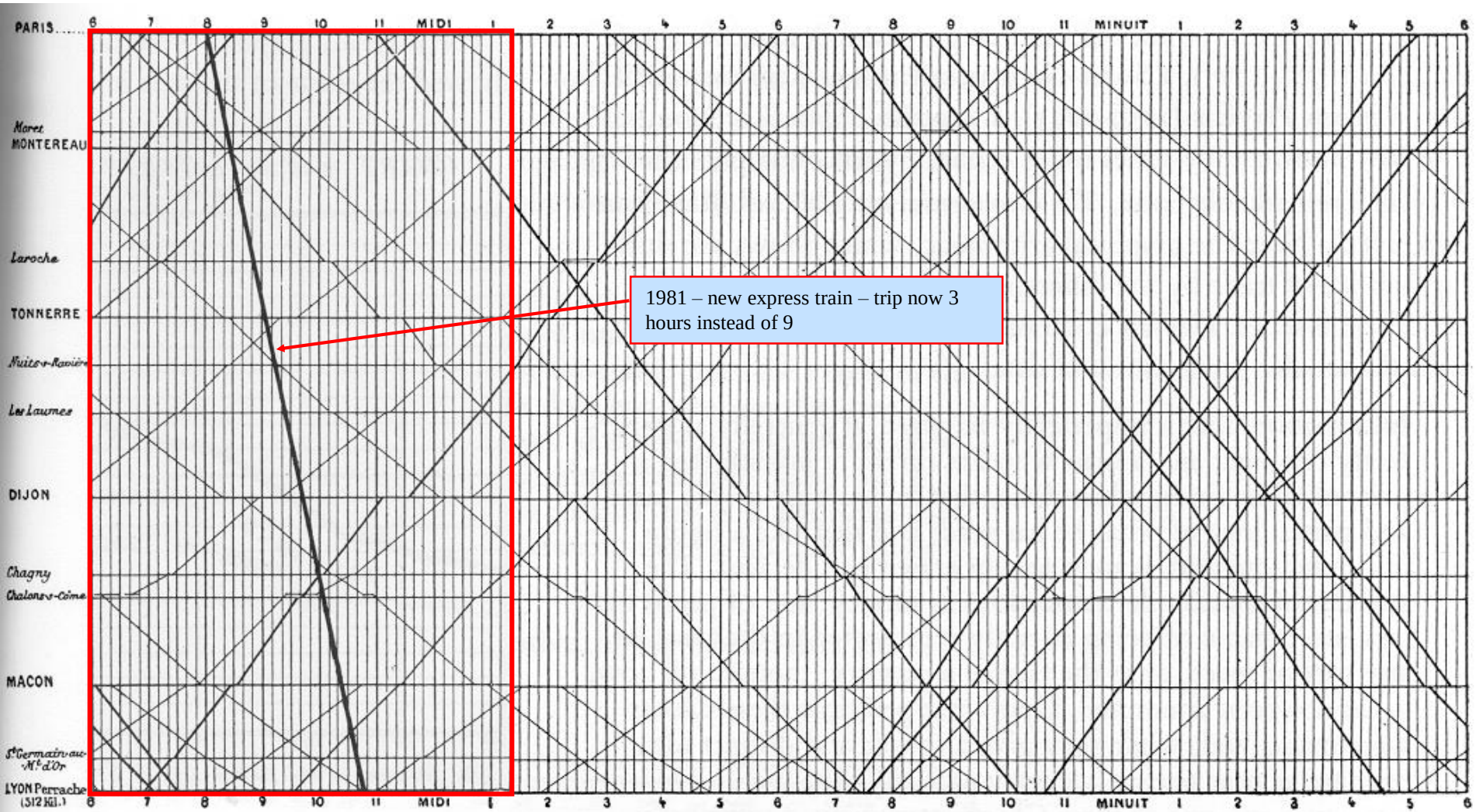
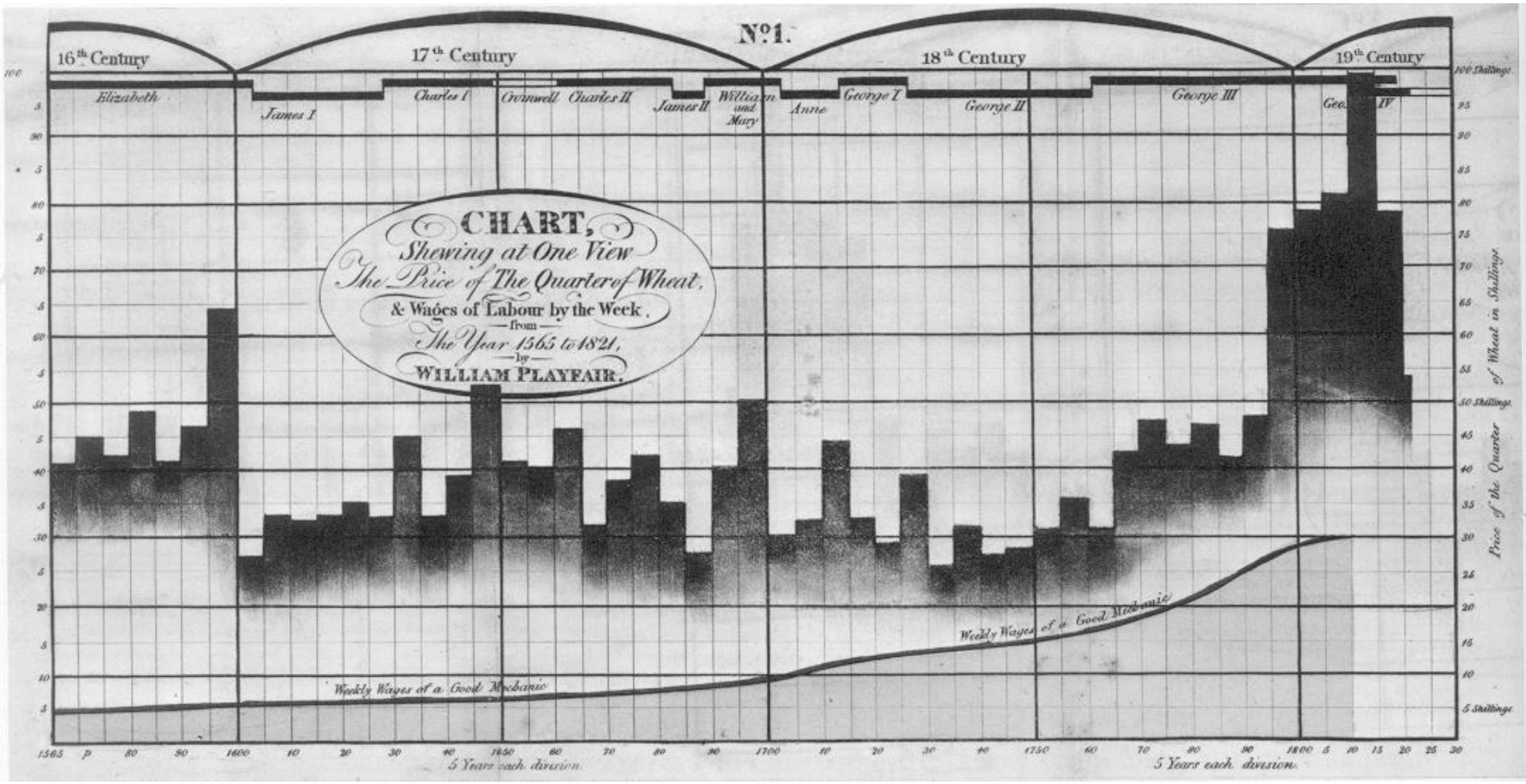


L. Tilling, "Early Experimental Graphs," British Journal for the history of Science, 8 (1975) p.193-213, (Tufte, 1883, p.34)

Time Series

W. Playfair. 1759-1823. 3 time series – prices, wages and reigns of Kings and Queens



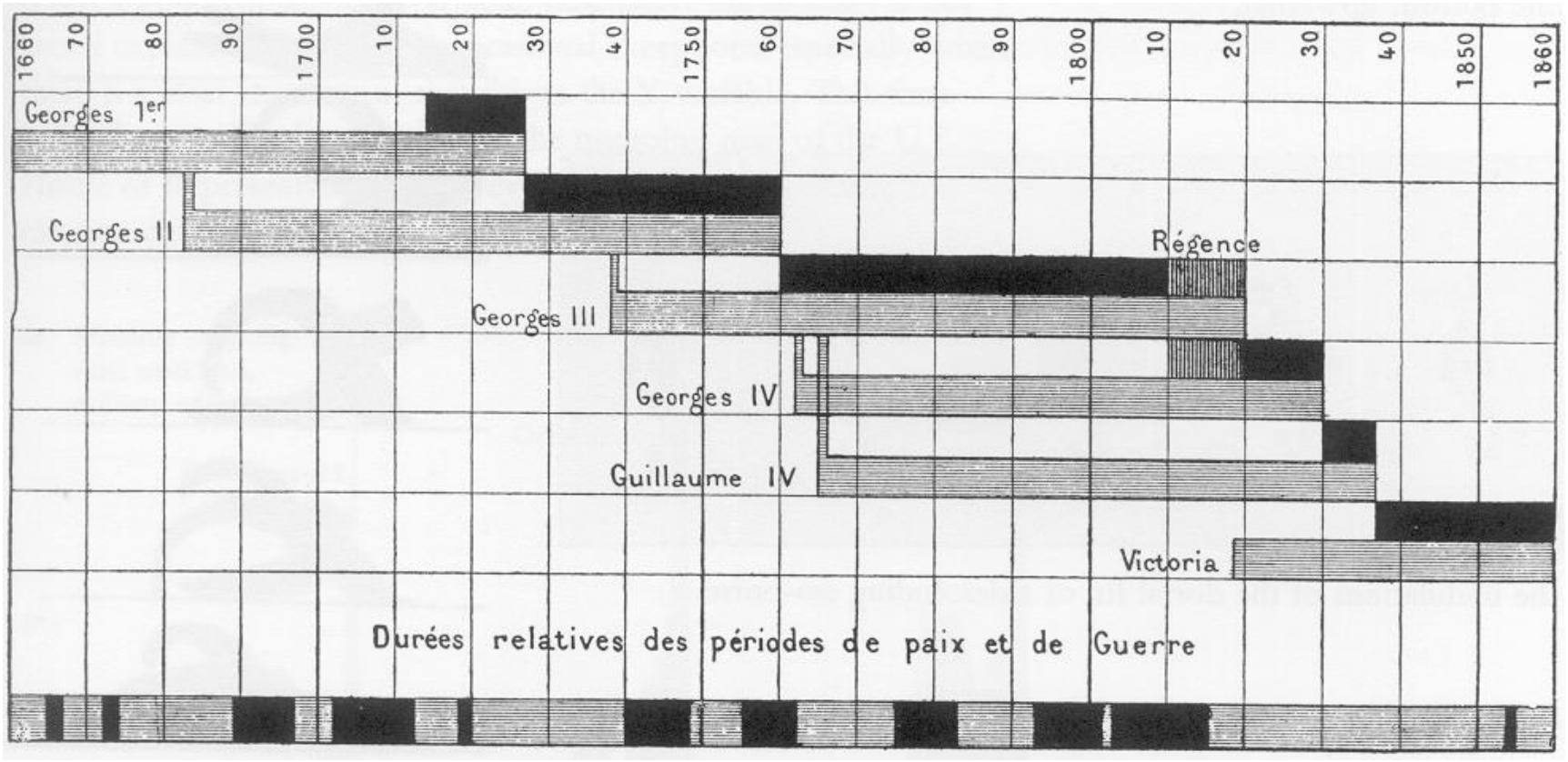
E. Tufte: Visual Display of Quantitative Information

E.J. Marey, "La Methode Graphique," (Paris 1885), p.6. (Tufte, 1983, p.35)

Time Series

E. Marey. 1885.

Shows the lives, the reigns, and the state of war or peace.

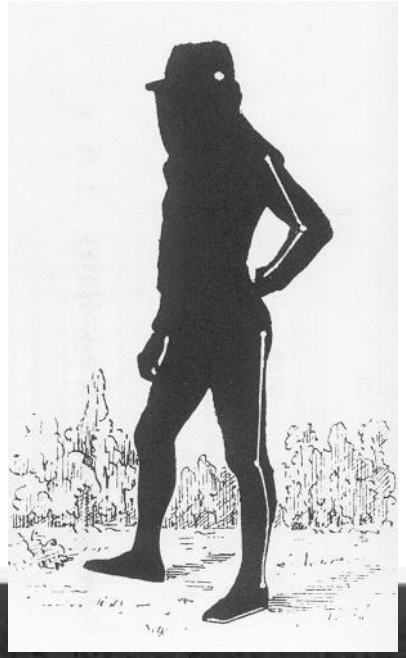


Time Series

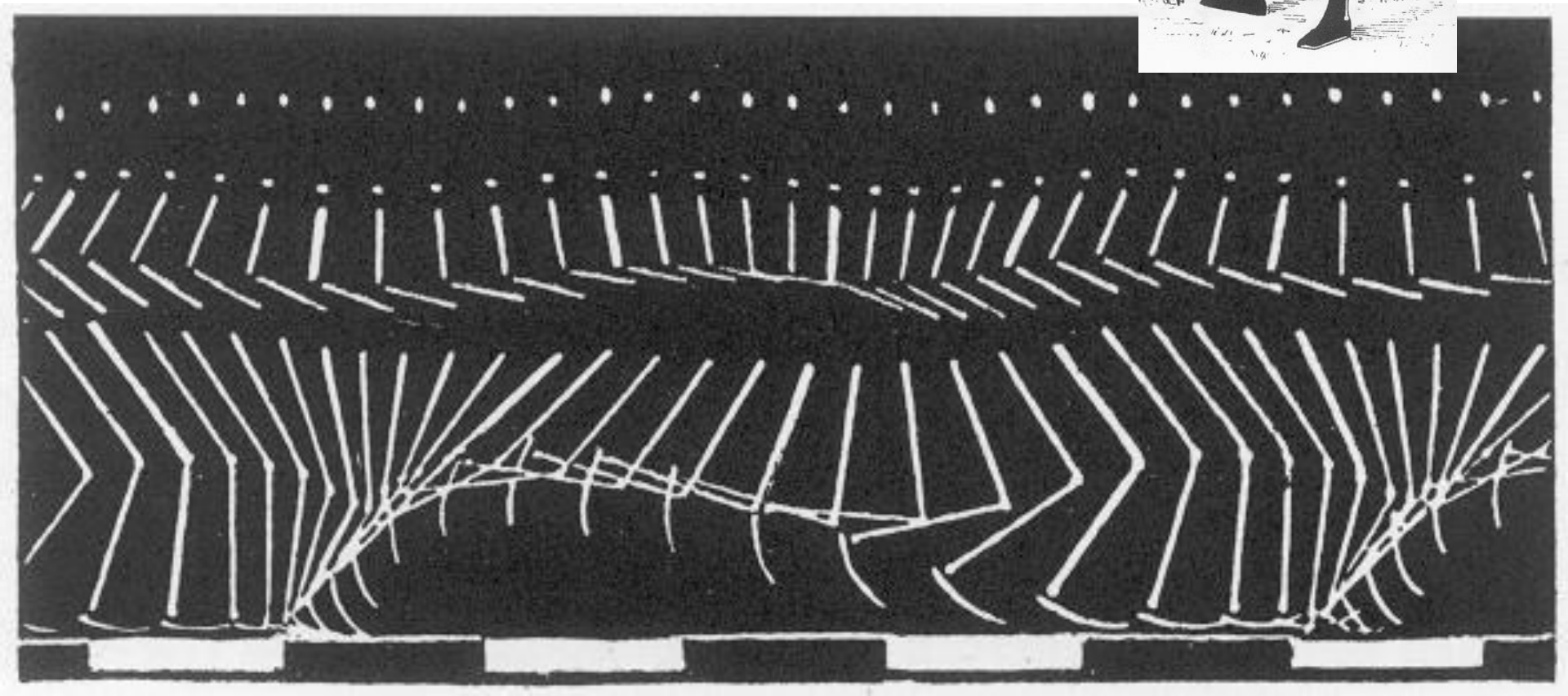
Diagrams of motion

Using white tape and black velvet, Marey created time series images.

E. J. Marey, (1830 – 1904)



E.J. Marey, “Movement,” (London 1895), p.60 and 61. (Tufte, 1883, p.35-36)



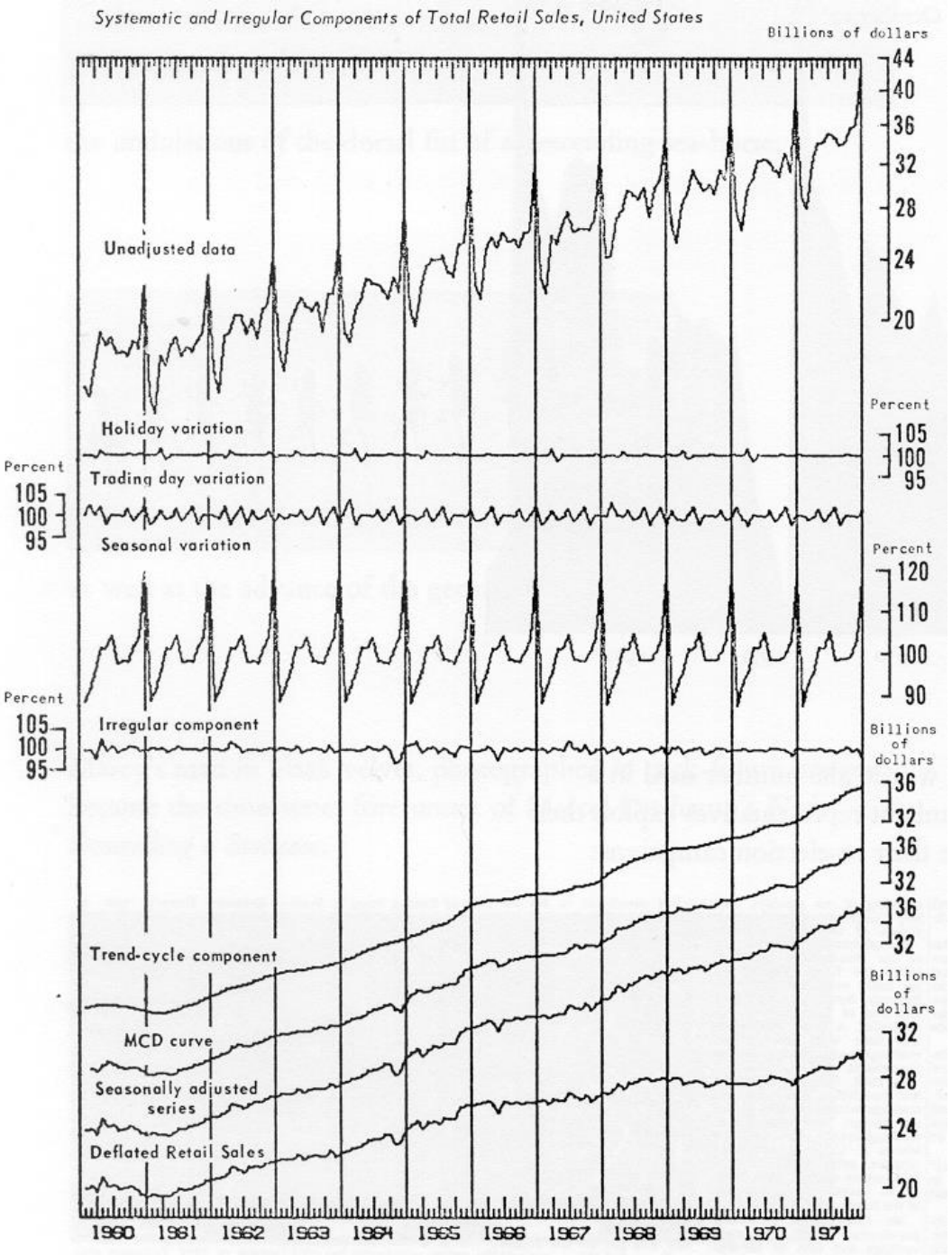
Time Series

Adjusted data

This time series shows all

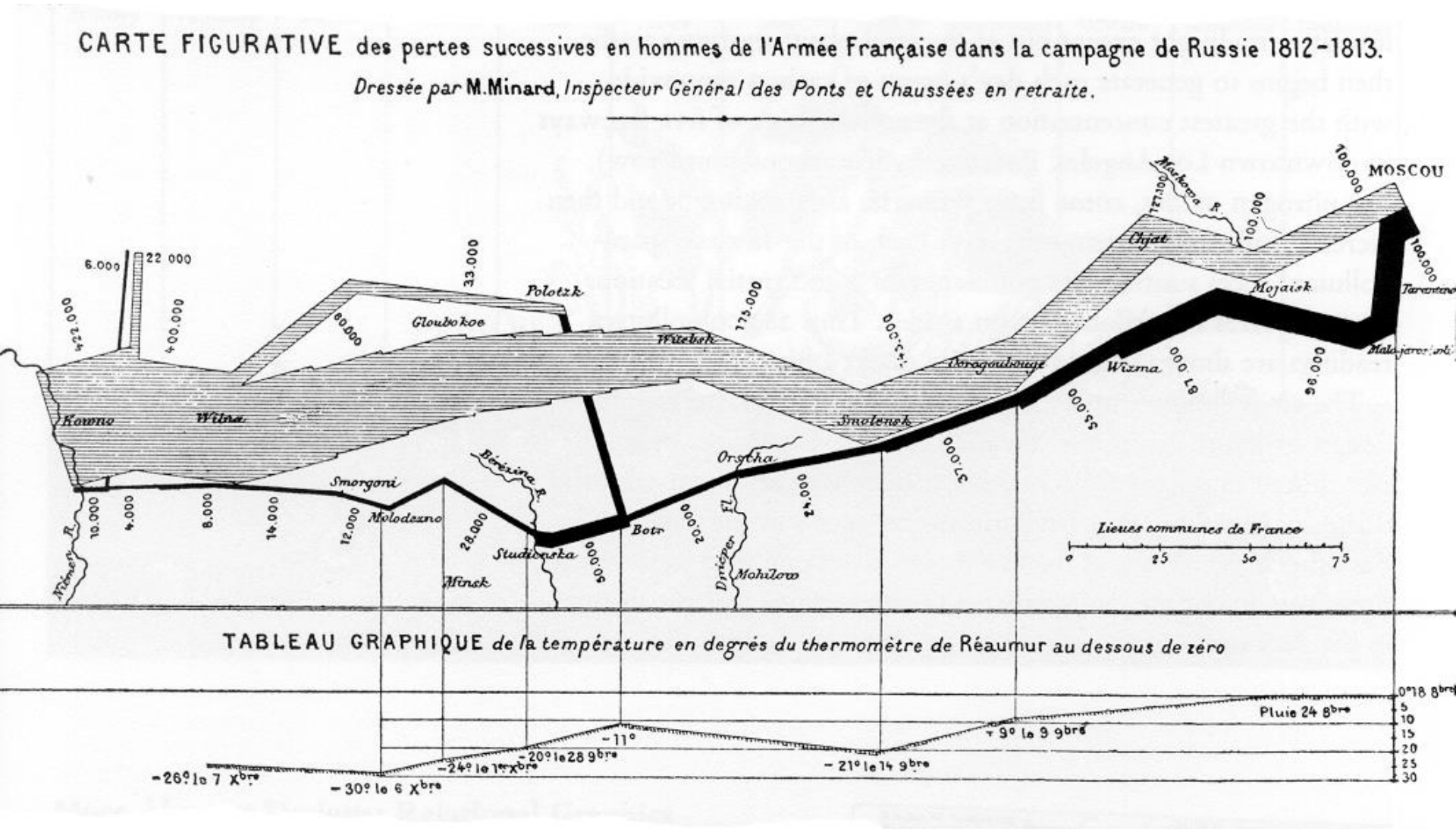
- the raw data
- the holiday and seasonal etc variations
- The adjusted date

However the vertical bars hide the December peaks



J. Shiskin, "Measuring Current Ecomoinc Flunctuations," Statistical reporter (July 1973), p.3. (Tufte, 1983, p.38)

Space-time story



C. J. Minard, French engineer, 1851

Telling a story: Napoleon's march to Moscow – combines statistical diagrams and maps

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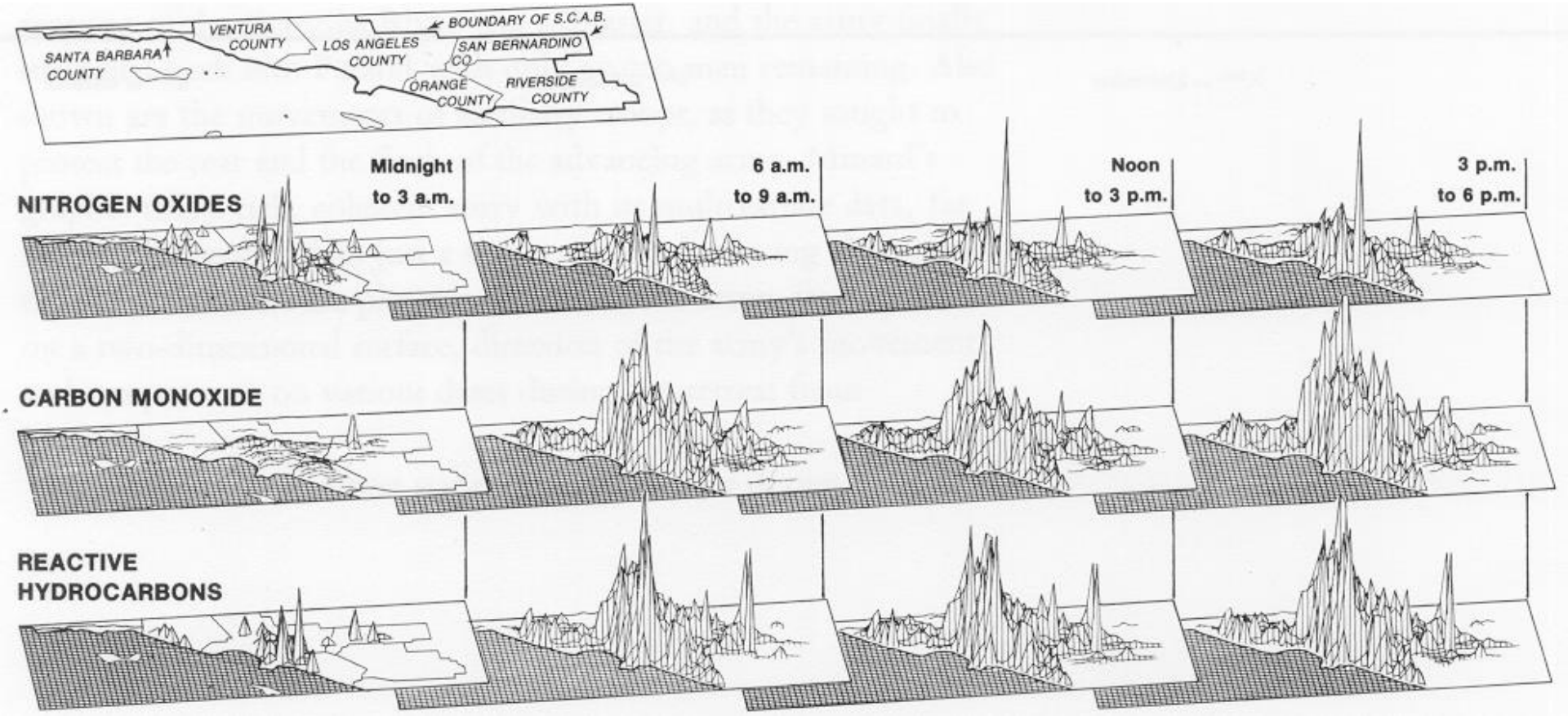
Space-time story

Small multiples

Learn once

Invite comparisons

Los Angeles Times, July 22, 1979; based on work of G. McRae, California Institute of technology. (Tufte, 1983, p.42)



L. H. Newman, Man and Insects (London 1965), p.104-105. (Tufte, 1983, p.43)

Space-time story

The life cycle of the Japanese beetle

Small multiples

Mixes space and time on the horizontal axis

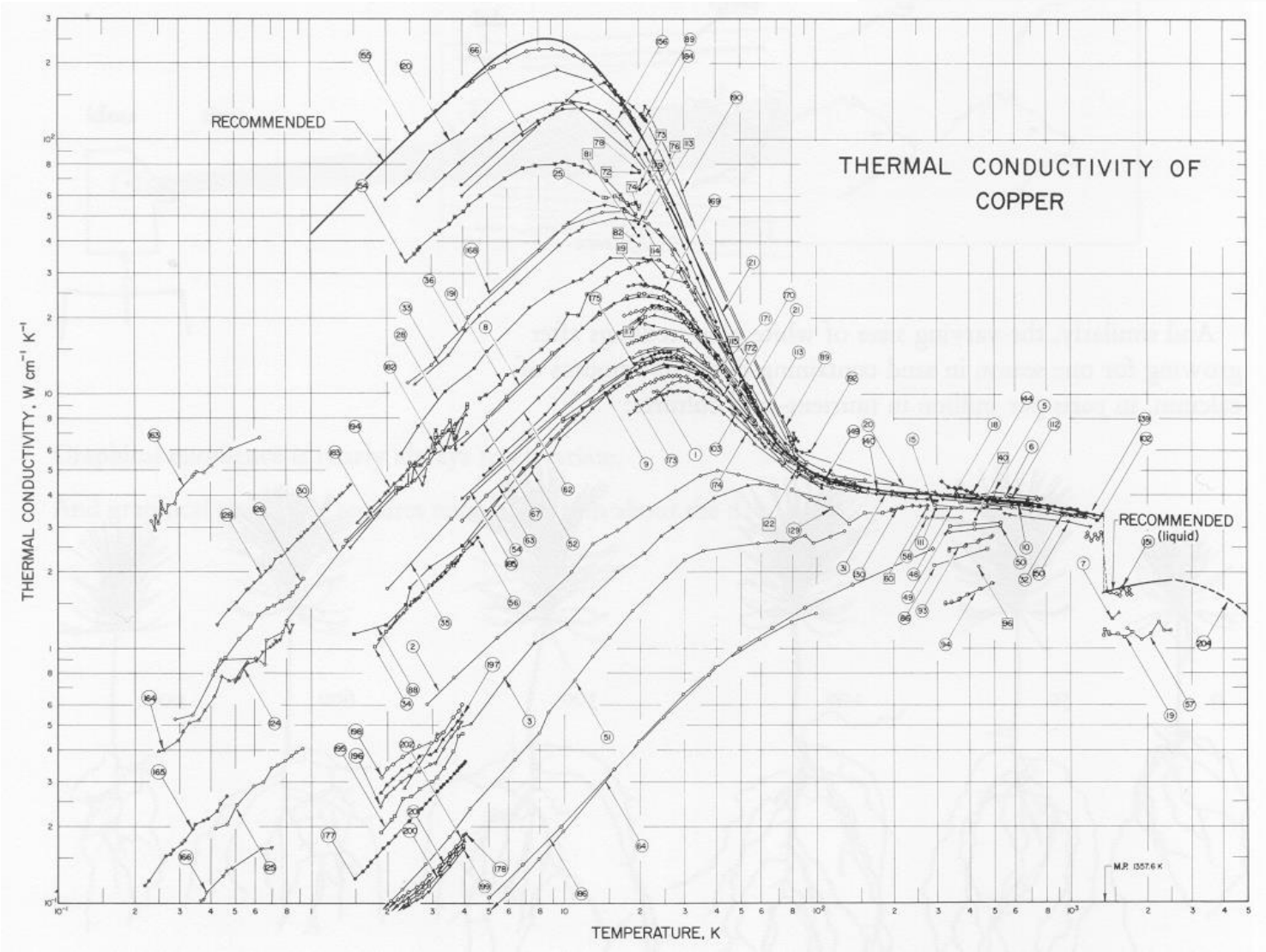
Location relative to the ground surface on the vertical axis

E

Relational Graphics

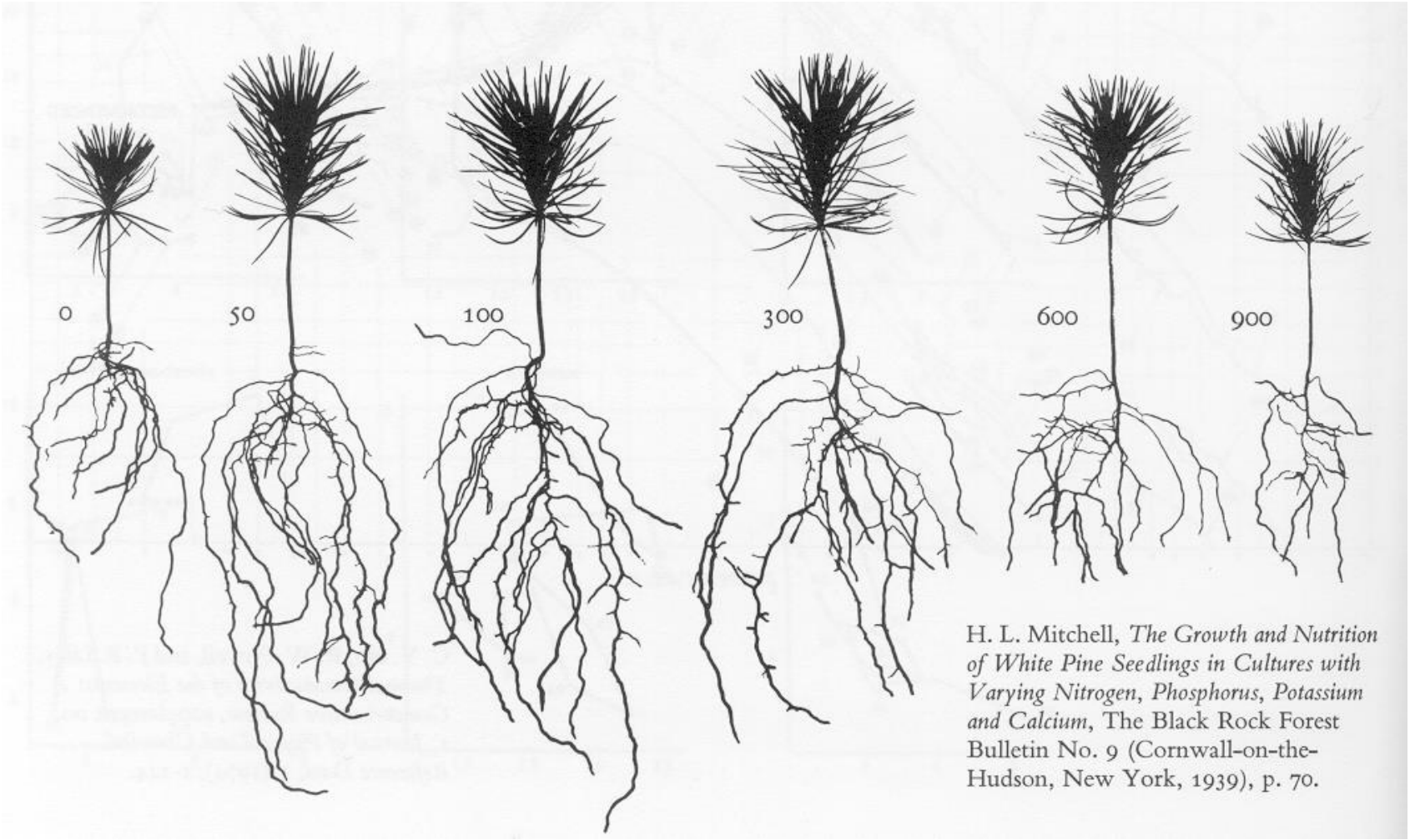
- Relationship between temperature and thermal conductivity of copper
- Gathers data from several laboratories
- Makes a clearer and stronger point by the collection
- Connected points are from one publication
- Different answers result from different impurities levels

C. Y. Ho, R. W. Powell, and P. E. Liley, *Thermal Conductivity of the Elements: A Comprehensive Review*, supplement no. 1, *Journal of Physical and Chemical Reference Data*, 3 (1974), 1–244.



Relational Graphics

The varying sizes of white pine seedlings after growing for one season in sand containing different amounts of calcium, in parts per million in nutrient sand cultures.



H. L. Mitchell, *The Growth and Nutrition of White Pine Seedlings in Cultures with Varying Nitrogen, Phosphorus, Potassium and Calcium*, The Black Rock Forest Bulletin No. 9 (Cornwall-on-the-Hudson, New York, 1939), p. 70.

Graphical Excellence - Summary

Designed for the presentation of interesting data – matter of substance, of statistics, and of design.

Graphical excellence consists of complex ideas communicated with clarity, precision and efficiency.

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.

- > ideas
- < time
- < ink
- < space

Graphical excellence is nearly always multivariate.

And is all about truth and integrity.

E. Tufte: Visual Display of Quantitative Information