With savage pictures fill their gaps
And o'er unhabitable downs
Place elephants for want of towns.

Jonathan Swift's indictment of 17th-century cartographers

5 *Chartjunk: Vibrations, Grids, and Ducks*

THE interior decoration of graphics generates a lot of ink that does not tell the viewer anything new. The purpose of decoration varies—to make the graphic appear more scientific and precise, to enliven the display, to give the designer an opportunity to exercise artistic skills. Regardless of its cause, it is all non-data-ink or redundant data-ink, and it is often chartjunk. Graphical decoration, which prospers in technical publications as well as in commercial and media graphics, comes cheaper than the hard work required to produce intriguing numbers and secure evidence.

Sometimes the decoration is thought to reflect the artist's fundamental design contribution, capturing the essential spirit of the data and so on. Thus principles of artistic integrity and creativity are invoked to defend—even to advance—the cause of chartjunk. There are better ways to portray spirits and essences than to get them all tangled up with statistical graphics.

Fortunately most chartjunk does not involve artistic considerations. It is simply conventional graphical paraphernalia routinely added to every display that passes by: over-busy grid lines and excess ticks, redundant representations of the simplest data, the debris of computer plotting, and many of the devices generating design variation.

Like weeds, many varieties of chartjunk flourish. Here three widespread types found in scientific and technical research work are catalogued—unintentional optical art, the dreaded grid, and the self-promoting graphical duck. A hundred chartjunky examples from commercial and media graphics have been forgone so as to demonstrate the relevance of the critique to the professional scientific production of data graphics.

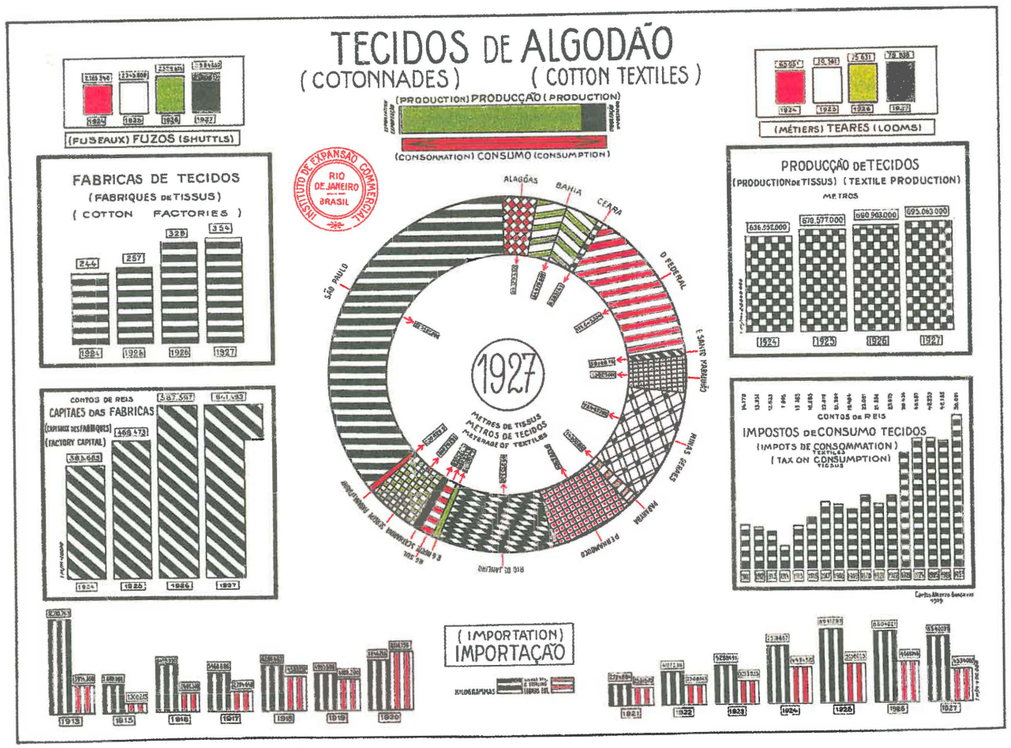
Unintentional Optical Art

Contemporary optical art relies on moiré effects, in which the design interacts with the physiological tremor of the eye to produce the distracting appearance of vibration and movement.

The effect extends beyond the ink of the design to the whole page. When exploited by the experts, such as Bridget Riley and Victor Vasarely, op art effects are undoubtedly eye-catching.

But statistical graphics are also often drawn up so as to shimmer. This moiré vibration, probably the most common form of graphical clutter, is inevitably bad art and bad data graphics. The noise clouds the flow of information as these examples from technical and scientific publications illustrate:

Instituto de Expansão Commercial, *Brasil: Graphicos Economicos-Estatisticas* (Rio de Janeiro, 1929), 15.



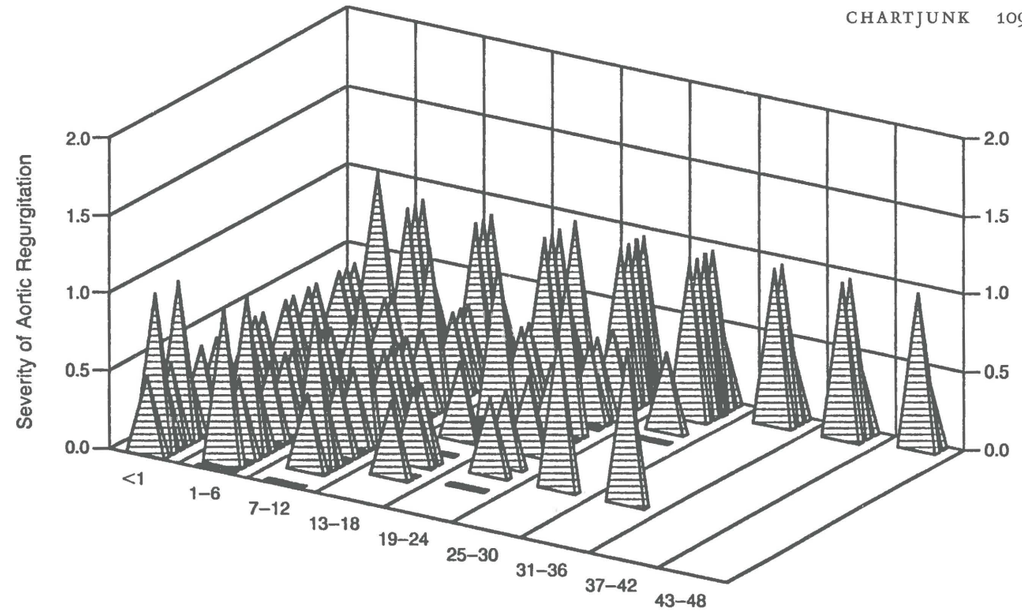
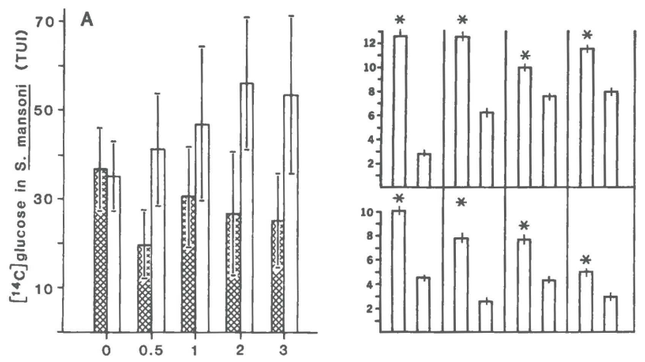


Figure 2. Serial Echocardiographic Assessments of the Severity of Regurgitation in the Pulmonary Autograft in 31 Patients. The numerical grades were assigned according to the severity of regurgitation, as follows: 0, none; 0.5, trivial; 1.0 to 1.5, mild; 2.0, moderate; and 3.0, severe.

On this page, what should have been simple tables are turned into bad graphics published in major scientific journals. Above a duck moiré with an unintentional Necker Illusion, as the two back planes optically flip to the front. Some pyramids conceal others; and one variable (stacked depth of the stupid pyramids) has no label or scale. Below, we learn very little about data, but do discover that moiré vibration may well be at a maximum for equally spaced bars:

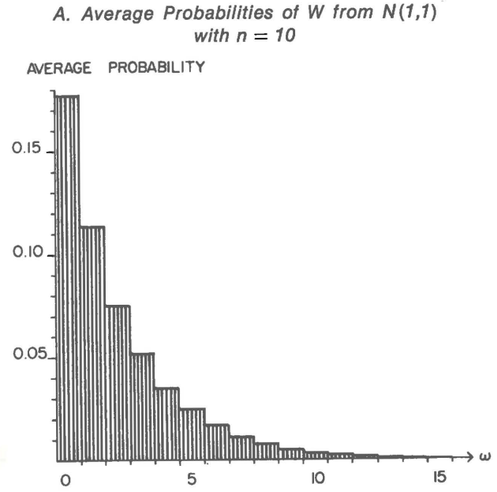
Nicholas T. Kouchoukos, *et al.*, "Replacement of the Aortic Root with a Pulmonary Autograft in Children and Young Adults with Aortic-Valve Disease," *The New England Journal of Medicine*, 330 (January 6, 1994), 4.



James T. Kuznicki and N. Bruce McCutcheon, "Cross-Enhancement of the Sour Taste on Single Human Taste Papillae," *Journal of Experimental Psychology: General*, 108 (1979), 76.

Eain M. Cornford and Marie E. Huot, "Glucose Transfer from Male to Female Schistosomes," *Science*, 213 (September 11, 1981), 1270.

And, finally, from the style sheet once provided by the *Journal of the American Statistical Association*, a graphic described as "an example of a figure prepared in the proper form":



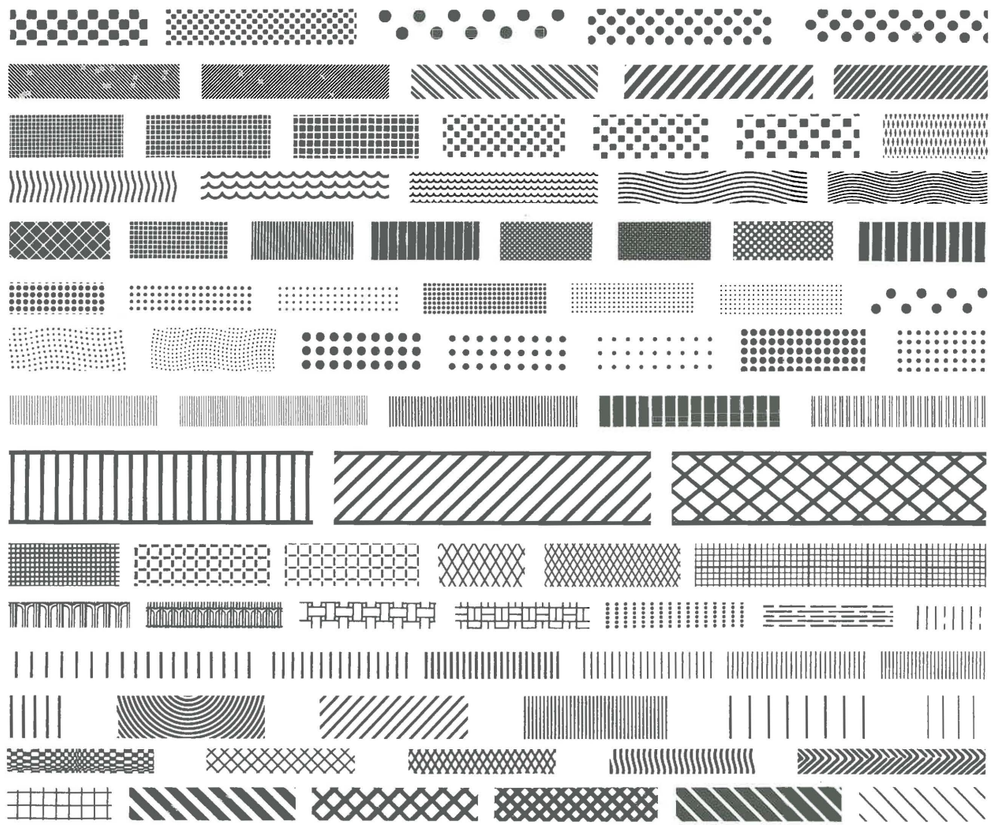
"JASA Style Sheet," *Journal of the American Statistical Association*, 71 (March 1976), 260–261.

The display required 131 line-strokes and 15 digits to communicate its simple information. The vibrating lines are poorly drawn, unevenly spaced, and misaligned with the vertical axis.

Vibrating chartjunk even frequents the graphics of major scientific journals:

The ten most frequently cited (footnoted) scientific journals: random sample of issues published 1980–1982	Percentage of graphics with moiré vibration	Number of graphics in sample
Biochemistry	2%	568
Journal of Biological Chemistry	2%	565
Journal of the American Chemical Society	3%	317
Journal of Chemical Physics	6%	327
Biochimica et Biophysica Acta	8%	432
Nature	11%	225
Proceedings of the National Academy of Sciences, U.S.A.	12%	438
Lancet	15%	364
Science	17%	311
New England Journal of Medicine	21%	338

Moiré effects have proliferated with computer graphics (in programs such as Excel). Such unfortunate patterns were once generated by means of thin plastic transfer sheets; now the computer produces instant chartjunk. Shown here are a few of the many vibrating possibilities. Cross-hatching should be replaced with tint screens of shades of gray. Specific areas on a graphic should be labeled with words rather than encoded with hatching.



This form of chartjunk is a twentieth-century innovation, and computer graphics are multiplying it more than ever. The handbooks and textbooks of statistical graphics, along with user's manuals for computer graphics programs, are filled up with vibrating graphics, presented as exemplars of design. Note the high

proportion of chartjunky graphics in the more recent publications. Computer graphics are particularly active:

Textbooks and handbooks of statistical graphics; and manuals for computer graphics programs (ordered by date of publication)	Percentage of graphics with moiré vibration	Total number of graphics
Willard C. Brinton, *Graphic Methods for Presenting Facts* (New York, 1914)	12%	255
R. Satet, *Les Graphiques* (Paris, 1932)	29%	28
Herbert Arkin and Raymond R. Colton, *Graphs: How to Make and Use Them* (New York, 1936)	17%	95
Mary Eleanor Spear, *Charting Statistics* (New York, 1952)	46%	134
Anna C. Rogers, *Graphic Charts Handbook* (Washington, DC, 1961)	32%	201
F. J. Monkhouse and H. R. Wilkinson, *Maps and Diagrams* (London, third edition, 1971)	14%	322
Calvin F. Schmid and Stanton E. Schmid, *Handbook of Graphic Presentation* (New York, second edition, 1979)	22%	399
A. J. MacGregor, *Graphics Simplified* (Toronto, 1979)	34%	65
The user's manual for a widely distributed computer graphics package: *SAS/GRAPH User's Guide* (Cary, North Carolina, 1980)	68%	28
The manual for a very extensive computer graphics program: *Tell-A-Graf User's Manual* (San Diego, 1981)	53%	459

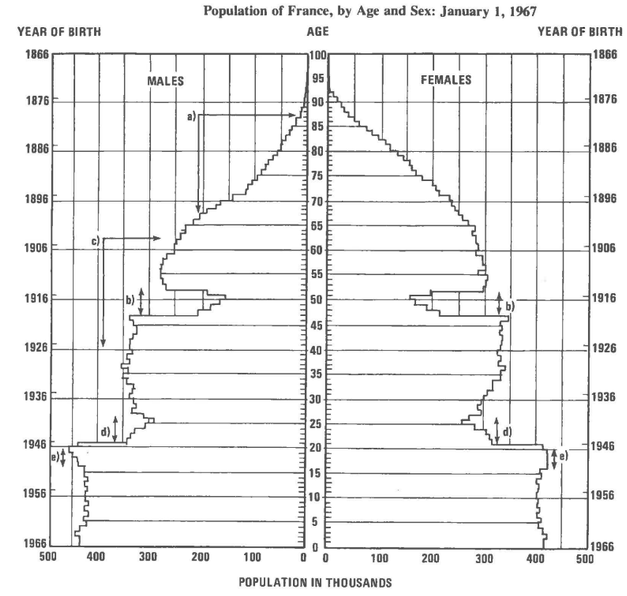
Can optical art effects ever produce a better graphic? Bertin exhorts: "It is the designer's duty to make the most of this variation; to obtain the resonance [of moiré vibration] without provoking an uncomfortable sensation: to flirt with ambiguity without succumbing to it."[1] But can statistical graphics successfully "flirt with ambiguity"? It is a clever idea, but no good examples are to be found. The key difficulty remains: moiré vibration is an *undisciplined* ambiguity, with an illusive, eye-straining quality that contaminates the entire graphic. It has no place in data graphical design.

The Grid

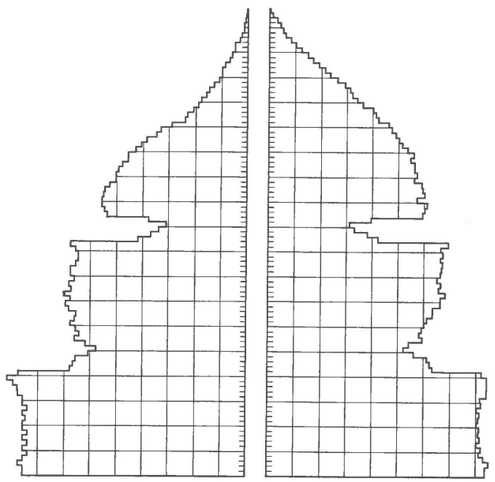
One of the more sedate graphical elements, the grid should usually be muted or completely suppressed so that its presence is only implicit—lest it compete with the data. Grids are mostly for the initial plotting of data at home or office rather than for putting

[1] Jacques Bertin, *Semiology of Graphics: Diagrams, Networks, Maps* (Madison, Wisconsin, 1983, translated by William J. Berg), 80; this book is the English translation of Bertin's important work, *Sémiologie graphique* (Paris, 1967).

into print. Dark grid lines are chartjunk. They carry no information, clutter up the graphic, and generate graphic activity unrelated to data information. This grid camouflages the profile of the data in the age-sex pyramid of the population of France in 1967:



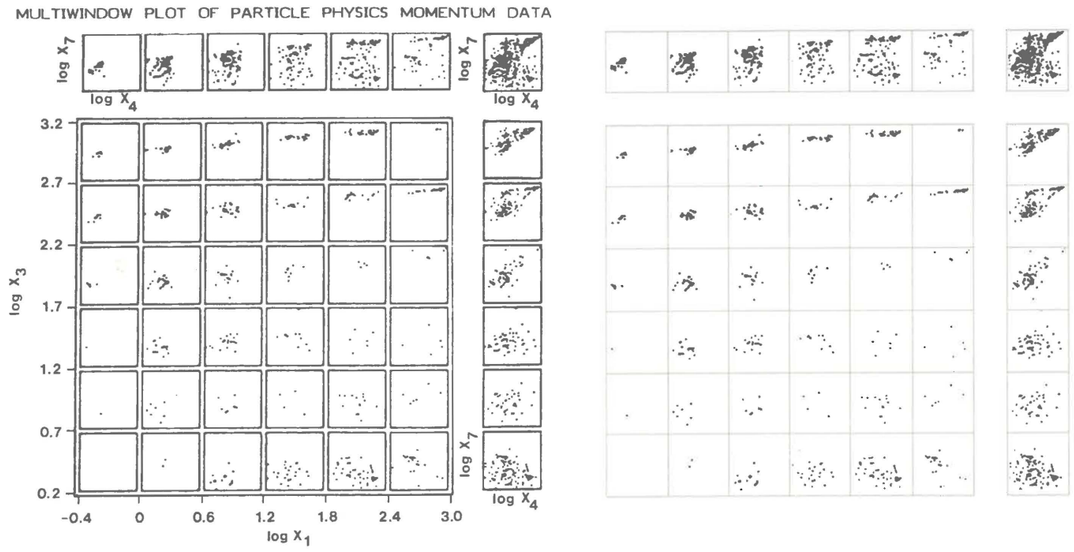
A revision quiets the grid and gives emphasis to the data:



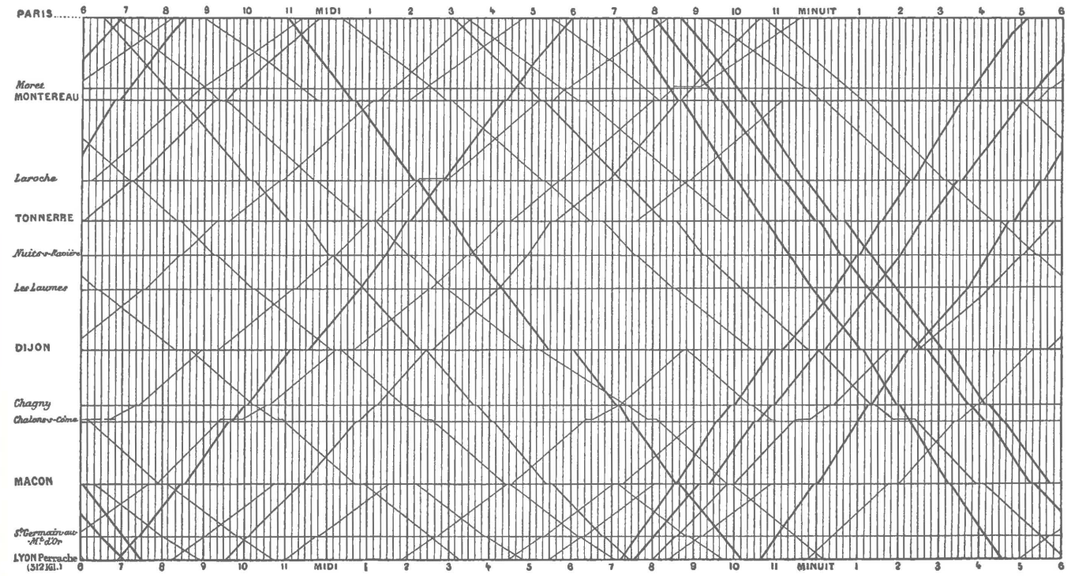
Based on data in Institut National de la Statistique et des Études Économiques, *Annuaire statistique de la France, 1968* (Paris, 1968), 32–33; redrawn in Henry S. Shryock and Jacob S. Siegel, *The Methods and Materials of Demography* (Washington, DC, 1973), vol. 1, 242.

The space occupied by the doubled grid lines consumes 18 percent of the area of this otherwise most ingenious design, a "multiwindow plot." Optical white dots appear at the intersections of the grid lines. (The plot shows the following: The large square contains X_4, X_7 scatterplots for the indicated levels of X_1 and X_3. The marginal plots on the right are conditioned on X_3 and the plots at the top on X_1. The upper right corner shows the unconditional X_4, X_7 scatter.) Redrawing eliminates the vibration:

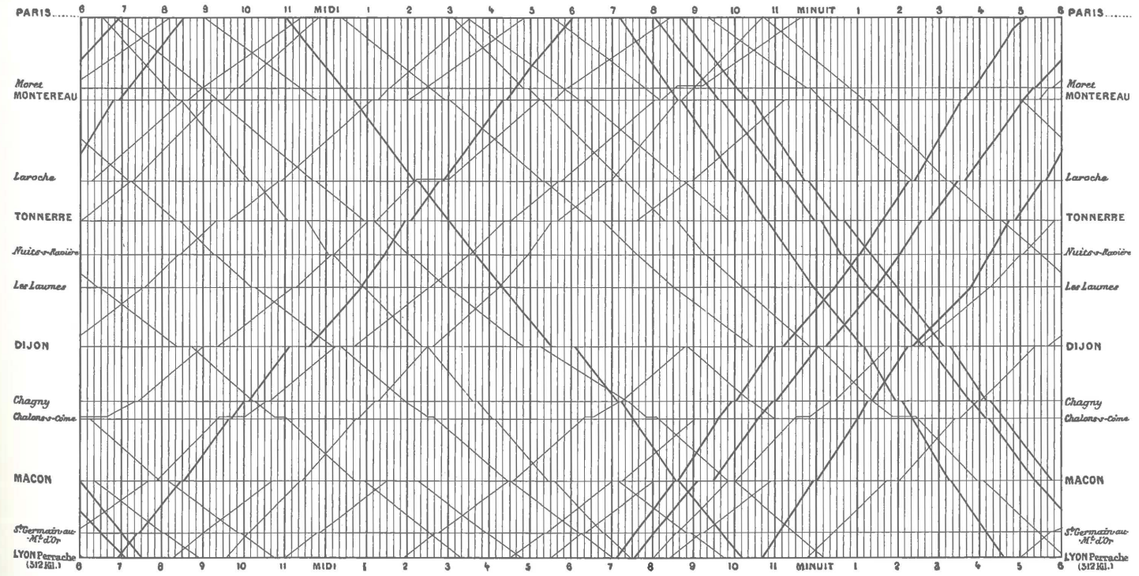
Paul A. Tukey and John W. Tukey, "Data-Driven View Selection; Agglomeration and Sharpening," in Vic Barnett, ed., *Interpreting Multivariate Data* (Chichester, England, 1981), 231–232.



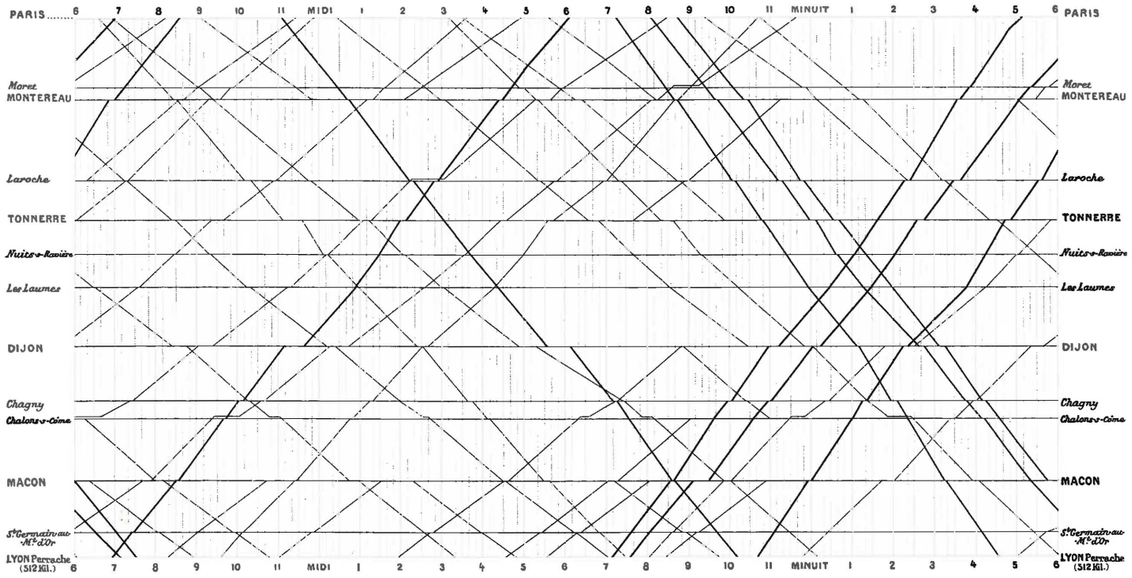
The grid in the classic Marey train schedule is very active:



Thinning the grid lines helps a little bit:



A better treatment, however, is a *gray grid*:



When a graphic serves as a look-up table, then a grid may help in reading and interpolating. But even in this case the grids should be muted relative to the data. A gray grid works well and, with a delicate line, may promote more accurate data reconstruction than a dark grid.

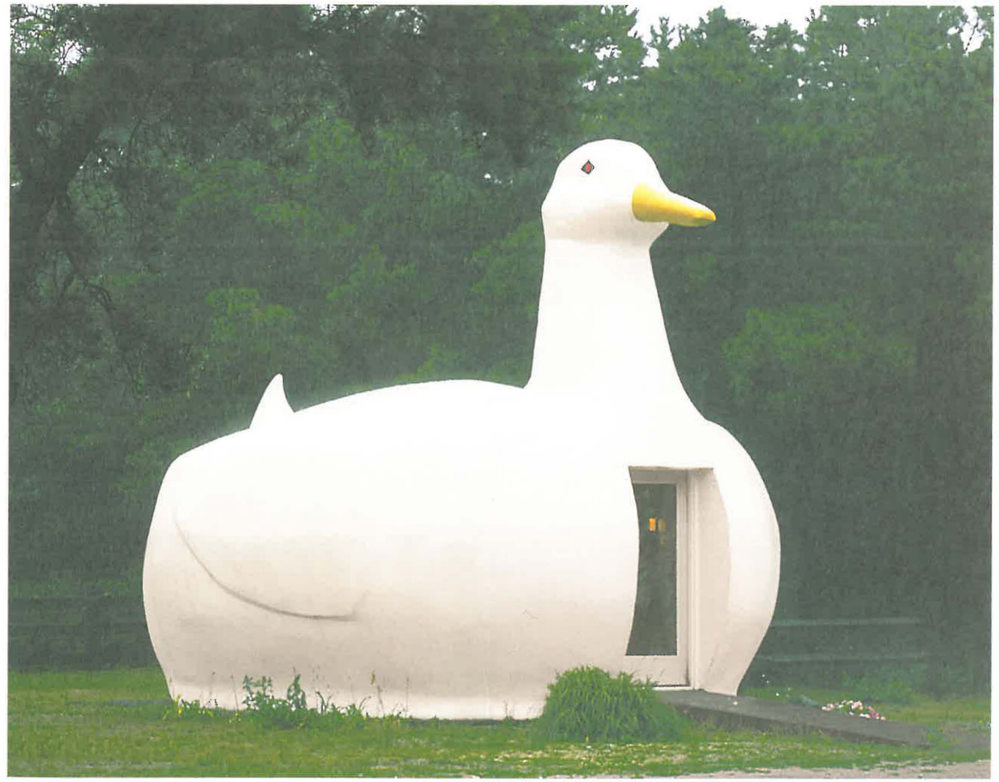
Most ready-made graph paper comes with a darkly printed grid. The reverse (unprinted) side should be used, for then the lines show through faintly and do not clutter the data. If the paper is heavily gridded on both sides, throw it out.

Self-Promoting Graphics: The Duck

When a graphic is taken over by decorative forms or computer debris, when the data measures and structures become Design Elements, when the overall design purveys Graphical Style rather than quantitative information, then that graphic may be called a *duck* in honor of the duck-form store, "Big Duck." For this building the whole structure is itself decoration, just as in the duck data graphic. In *Learning from Las Vegas*, Robert Venturi, Denise Scott Brown, and Steven Izenour write about the ducks of modern architecture—and their thoughts are relevant to the design of data graphics as well:

> When Modern architects righteously abandoned ornament on buildings, they unconsciously designed buildings that *were* ornament. In promoting Space and Articulation over symbolism and ornament, they distorted the whole building into a duck. They substituted for the innocent and inexpensive practice of applied decoration on a conventional shed the rather cynical and expensive distortion of program and structure to promote a duck. . . . It is now time to reevaluate the once-horrifying statement of John Ruskin that architecture is the decoration of construction, but we should append the warning of Pugin: It is all right to decorate construction but never construct decoration.[2]

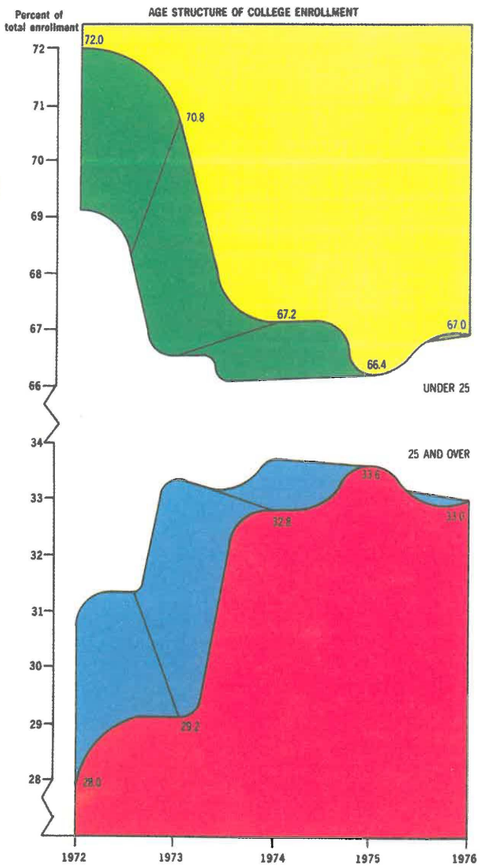
[2] Robert Venturi, Denise Scott Brown, and Steven Izenour, *Learning from Las Vegas* (Cambridge, revised edition, 1977), 163. The initial statement of the duck concept is found on 87–103.



Big Duck, Flanders, New York; photograph by Edward Tufte, July 2000.

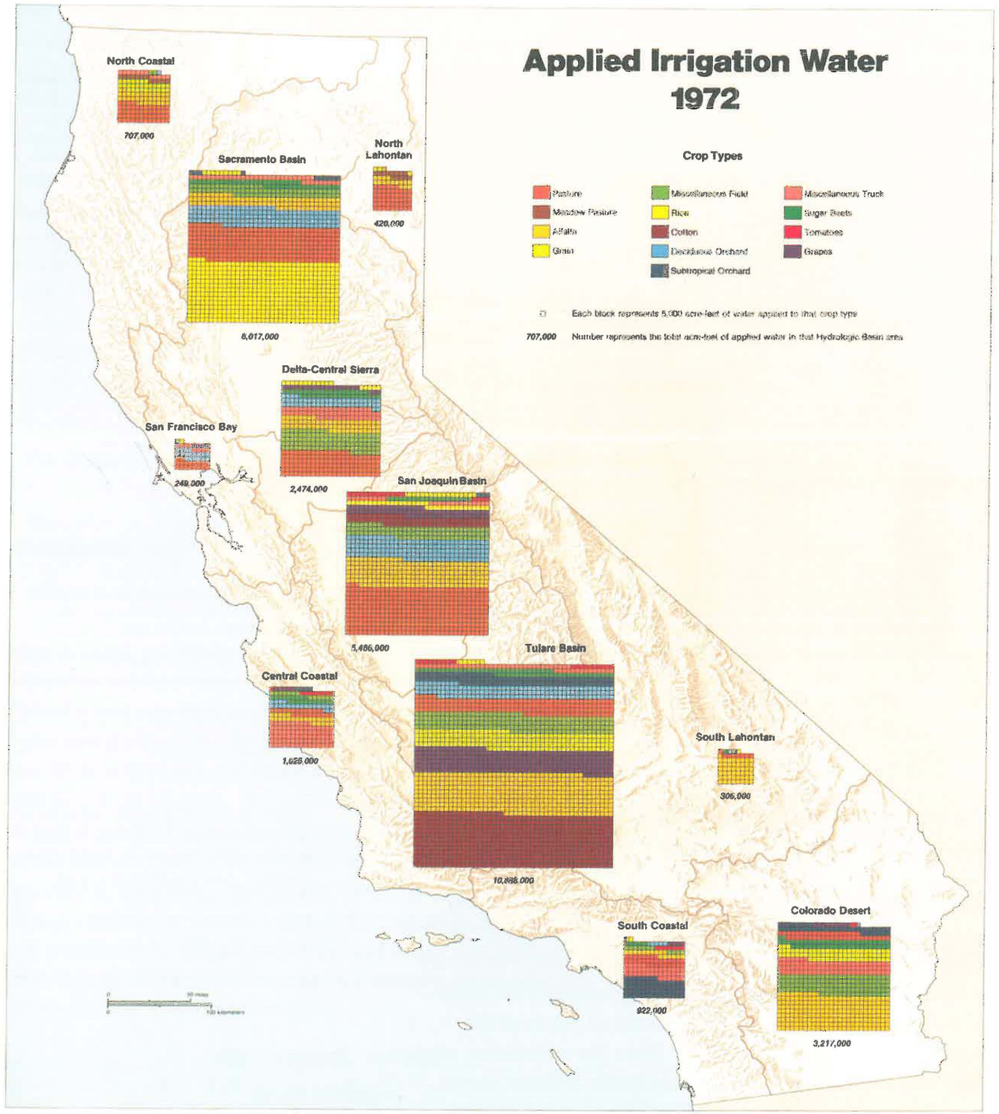
The addition of a fake perspective to the data structure clutters many graphics. This variety of chartjunk, now at high fashion in the world of Boutique Data Graphics, abounds in corporate annual reports, the phony statistical studies presented in advertisements, the mass media, and the more muddled sorts of social science research.

A series of weird three-dimensional displays appearing in the magazine *American Education* in the 1970s delighted connoisseurs of the graphically preposterous. Here five colors report, almost by happenstance, only five pieces of data (since the division within each year adds to 100 percent). This may well be the worst graphic ever to find its way into print:

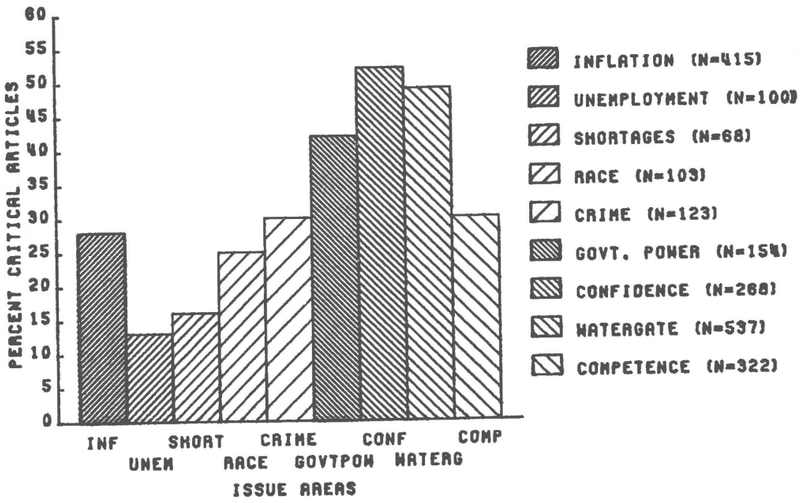


There are some superbly produced ducks:

William L. Kahrl, et al., *The California Water Atlas* (Sacramento, 1978, 1979), 55.



Occasionally designers seem to seek credit merely for possessing a new technology, rather than using it to make better designs. Computers and their affiliated apparatus can do powerful things graphically, in part by turning out the hundreds of plots necessary for good data analysis. But at least a few computer graphics only evoke the response "Isn't it remarkable that the computer can be programmed to draw like that?" instead of "My, what interesting data."



The symptoms of the We-Used-A-Computer-To-Build-A-Duck Syndrome appear in this display from a professional journal: the thin substance; the clotted, crinkly lettering all in upper-case sans serif; the pointlessly ordered cross-hatching; the labels written in computer abbreviations; the optical vibration—all these the by-products of the technology of graphic fabrication. The overly busy vertical scaling shows more percentage markers and labels than there are actual data points. The observed values of the percentages should be printed instead. Since the information consists of a few numbers and a good many words, it is best to pass up the computerized graphics capability this time and tell the story with a table:

Arthur H. Miller, Edie N. Goldenberg, and Lutz Erbring, "Type-Set Politics: Impact of Newspapers on Public Confidence," *American Political Science Review*, 73 (1979), 67–84.

Content and tone of front-page articles in 94 U.S. newspapers, October and November, 1974	Number of articles	Percent of articles with negative criticism of specific person or policy
Watergate: defendants and prosecutors, Ford's pardon of Nixon	537	49%
Inflation, high cost of living	415	28%
Government competence: costs, quality, salaries of pubic employees	322	30%
Confidence in government: power of special interests, trust in political leaders, dishonesty in politics	266	52%
Government power: regulation of business, secrecy, control of CIA and FBI	154	42%
Crime	123	30%
Race	103	25%
Unemployment	100	13%
Shortages: energy, food	68	16%

Conclusion

Chartjunk does not achieve the goals of its propagators. The overwhelming fact of data graphics is that they stand or fall on their content, gracefully displayed. Graphics do not become attractive and interesting through the addition of ornamental hatching and false perspective to a few bars. Chartjunk can turn bores into disasters, but it can never rescue a thin data set. The best designs (for example, Minard on Napoleon in Russia, Marey's graphical train schedule, the cancer maps, the *Times* weather history of New York City, the chronicle of the annual adventures of the Japanese beetle, the new view of the galaxies) are *intriguing and curiosity-provoking*, drawing the viewer into the wonder of the data, sometimes by narrative power, sometimes by immense detail, and sometimes by elegant presentation of simple but interesting data. But no information, no sense of discovery, no wonder, no substance is generated by chartjunk.

Forgo chartjunk, including
moiré vibration,
the grid, and the duck.