

M I N D I N G I N F O R M A T I O N

G R A P H I C S

Editors and designers have always appreciated the power of information graphics to draw readers into a story and to help them understand its content. But until recently, the ability to create sophisticated "infographics" resided mostly with larger publications. Now, though, desktop publishing and the availability of software programs that make complicated data easy to display have brought infographics to all levels of magazine publishing. In part because they are so easy to create, many graphics now appearing in magazines sacrifice comprehensibility on the altar of aesthetics—a practice that is not only self-defeating, but unnecessary.

The human visual system, although remarkably powerful, is limited in critical ways, and these limitations directly influence how we perceive, understand and remember information graphics. Over the past decade, new discoveries in cognitive science (the study of how the mind and brain process information) have led to the recognition that some methods of representing information graphically are more effective than others. Art directors using infographics need to design for the reader's mind as well as the magazine's page. What follows are some guidelines for designers working with infographics.

Determine the title or caption before beginning to draw.

Decide what you want to communicate before doing anything else! Data can take on lives of their own and charge ahead, dragging the design (and the designer) behind them. For example, if your research for an article on the automobile industry turns up a table of the number of cars sold by various manufacturers over several years, you may be tempted to plot all the data in a single graph (Figure 1, top). But if the article exam-

ines industry trends over time rather than comparing different companies, a title of "Automobile Sales, 1986-1990" is more appropriate. That should lead you to conclude that combining the data from several companies for each year is more informative (Figure 1, bottom).

This approach works because readers expect illustrations to answer questions posed by a story. Therefore, graphic displays are easier to understand if they focus on the information the viewers are looking for, and don't surprise them with more (or less) than expected.

Use graphs to illustrate relative quantities.

Numbers can be displayed in a table or as elements of a graph (Figure 2, top). Although graphs are wonderful devices, they have weaknesses, too. The viewer registers the contents of a graph as variations along a visual dimension, such as the slope of a line, height of a bar, or the area of a wedge, and must relate such variations to a separate scale to obtain the exact quantities.

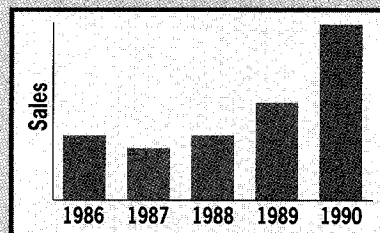
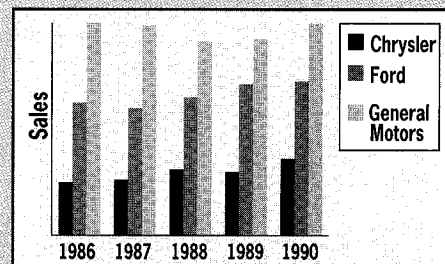
Different systems in the human brain extract information about shapes and locations, however, and effort is required to combine the two kinds of information precisely. Hence, it is difficult to read precise values from a graph. If the reader requires specific values, use a table (Figure 2, bottom). But because our visual systems readily note relative visual quantities, relative values should be displayed in graphs.

Present no more than four perceptual units in a single panel.

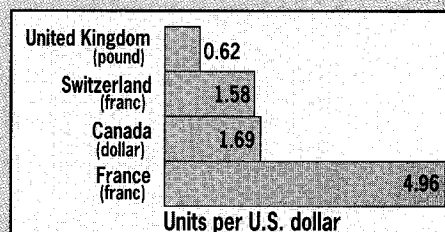
Studies have shown that we can keep in mind only about four "chunks" of perceptual data at once, so each panel of a display should contain, at most, that many chunks. A good rule for deciding what kind of data can be grouped togeth-

Knowing a little about human perception can help you make your graphics a lot more informative.

By Stephen M. Kosslyn, Ph.D. and Christopher F. Chabris

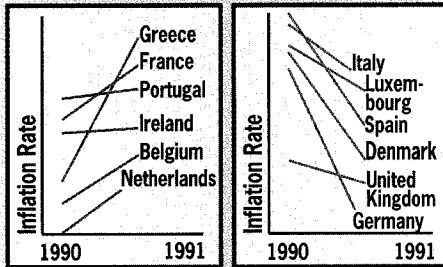
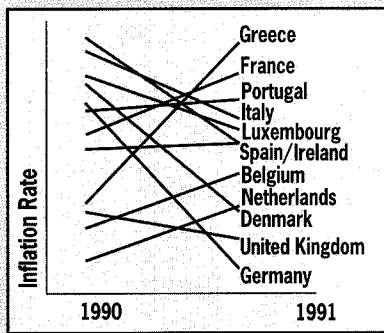


1. If the title is "U.S. Automobile Sales, 1986-1990," the bottom graph is more appropriate than the top, which obscures the overall trend by presenting the data for each manufacturer. By contrast, the top graph would better accompany an article that compared manufacturers within the industry.

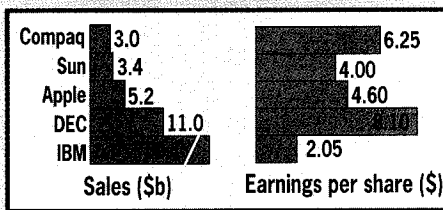
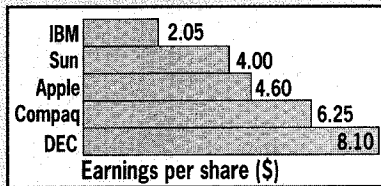


Country	Currency	Units per U.S. dollar	U.S. dollars per unit
Canada	dollar	1.69	0.59
France	franc	4.96	0.20
Switzerland	franc	1.58	0.63
United Kingdom	pound	0.62	1.61

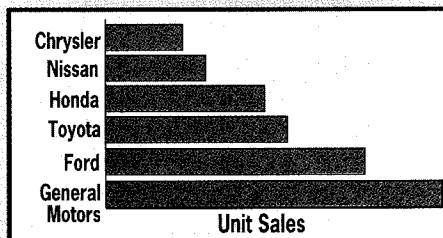
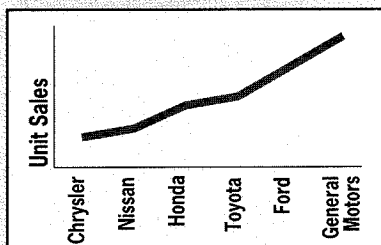
2. Currency exchange rates are not relative quantities, so the graph on top is less effective than the table beneath it.



3. To avoid "perceptual overload" of the top graph of inflation trends in EC countries, present the information in separate panels.



4. To display sales and profit data for selected computer industry firms, pair the sales graph at bottom left with the profits graph to its right. The side-by-side arrangement also eliminates the need to repeat the bar labels on the second panel.



5. The bar graph of unit automobile sales in the U.S. is more effective than the line graph because each bar represents a specific point value, whereas the points that make up the line are hard to separate visually.

er as a chunk is that elements should be similar along at least one visual dimension, such as color, orientation or shape (Figure 3).

For example, "xxx xxx" is seen as two chunks, whereas "xx xx xx" is seen as three (because of proximity), even though both patterns contain six x's. Additionally, parallel lines, bars of equal height, and bars that form a simple pattern are all grouped into single chunks.

Plot a variable in the same place in different panels.

If there is too much information to plot in a single panel (Figure 4, top), plot corresponding information in corresponding places in the different panels (Figure 4, bottom). This will group data together by similarity, and allow the reader to make comparisons easily. Moreover, brain cells typically are sensitive to changes rather than absolute quantities, so if something changes in a visual display, readers will assume it has importance. This principle of "informative change" suggests that the panels of a display should vary only when new information is conveyed—readers will be distracted by differences that have no meaning.

Use multiple panels to highlight specific comparisons.

Even if you could plot all your data in a single display without creating a confusing mishmash, it is sometimes better to use multiple panels. Lines with similar shapes or bars that form simple

patterns tend to be seen as a single group, but that perception might not coincide with the point you are trying to make. Present data to be compared in separate panels to ensure that the comparison stands out to the reader.

Use a bar graph to illustrate relative point values.

In a bar graph, the length of each bar represents a relative quantity—that is, a single data point, such as the number of cars sold by Honda in 1989. If spaces are provided between bars, the bars will be seen as individual visual units that specify one value each, and can be easily compared (Figure 5, bottom). In contrast, a line graph is inappropriate when points must be compared, because each point is naturally seen as part of a larger line, and must be mentally separated from that line before it can be compared to other points (Figure 5, top). Line graphs are better for illustrating trends, especially over time.

Do not use bar graphs to illustrate interactions.

If your goal is to illustrate how the effects of one variable are influenced by the values of another, such as the interaction of sex with race in predicting median income, a line graph is better than a bar graph. Bar graphs effectively illustrate point values and simple trends, but readers must "mentally connect" the ends of the bars to see how the two values interact (Figure 6, left). Line graphs make this information explicit and cap-

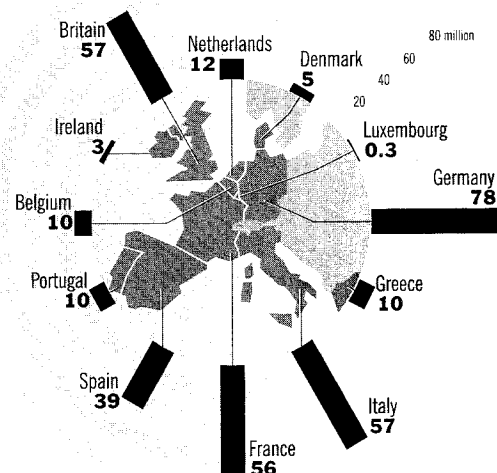
HOLMES'S WORK

FOLIO: asked infographics pioneer Nigel Holmes to apply his inventive techniques to some of Kosslyn's and Chabris' chart examples. His comments:

Figure 7

Since the countries of the European Community are clustered together geographically, it was easy to link their populations with their map locations. The fact that there are 12 countries suggests a clock face as a convenient metaphor upon which to display the data.

Populations of EC countries



italize on our ability to detect readily even small differences in orientation (Figure 6, right). Moreover, line graphs often produce easily recognizable patterns, such as the X-pattern to indicate volatility or relationships.

Order nominal values to produce the simplest pattern.

Suppose you are creating a bar graph of the current populations of European countries for an article on the economic unification of the continent. It might be tempting to order the bars alphabetically by country (Figure 7, top). However, all else being equal, the best organization is likely to be in ascending order of population (Figure 7, bottom), which not only creates a simple visual pattern that is easier to perceive and remember, but also facilitates gross qualitative comparisons (in a horizontal format a country whose bar is above another has a smaller population) and specific comparisons between bars of similar sizes (because they are close together).

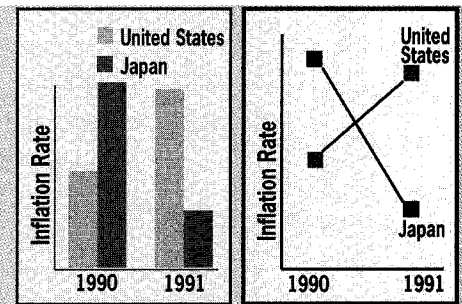
More visual material indicates a greater amount.

This is so important that it might be termed the "central dogma" of quantitative graphics. Violating this principle of "more is more" is never a good idea. For example, a bar graph of crime rates in which longer bars specified cities that had more households *without* burglaries (Figure 8, top) may leave readers with a lasting wrong impression.

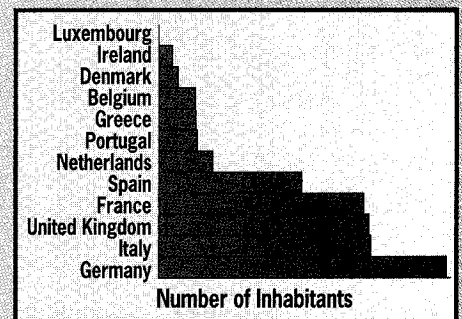
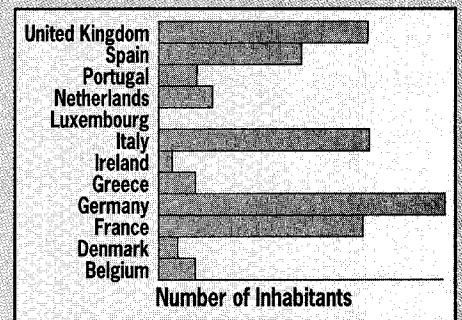
People expect more bar length to indicate more crime, not less. Similarly, don't indicate larger gross national products with smaller bars, or lower temperatures with higher points.

It might seem odd to worry about how the human mind functions when designing graphics, since envisioning ideas is so natural a part of our everyday lives. Why shouldn't we be able to understand any visual display we see? But when you write the words that graphics are meant to illustrate, you (unconsciously) follow an elaborate system of language rules—grammar, semantics, denotation, connotation, reference, and more—to ensure that your message is accurately received by your readers. Designing for the mind requires appreciating and exploiting the rules of the brain's visual language. Doing so will make your graphics highly readable, articulate and psychologically powerful. ■

Dr. Stephen M. Kosslyn is Professor of Psychology at Harvard University and author of the forthcoming book *Graphic Design for the Eye and Mind* (W. H. Freeman). **Christopher F. Chabris** is Artificial Intelligence Program Manager in the Psychology Department at Harvard University. Both are also with *Cognitive Applications, Inc.*, a consulting firm specializing in applied cognitive science. Most of the figures in the accompanying illustrations are schematic and represent fictitious data for illustration purposes.



6. The bar graph of inflation data makes it harder to see the interaction between country and year. The trend is up for one country and down for the other. The line graph makes the interaction jump out in an X-pattern.



7. Avoid needlessly complicated visual patterns like the one in the alphabetically displayed graph of EC country populations. Putting the bars in a simple, increasing pattern almost always aids rapid understanding.

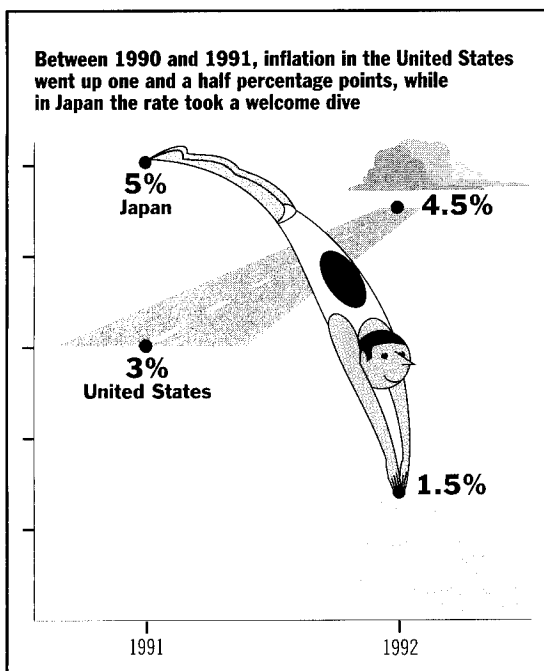
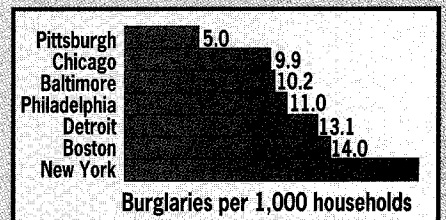
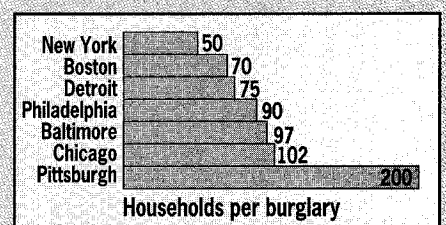


Figure 6
Strictly speaking, this solution is contrary to all the rules of charting. But we are only dealing with four numbers here; I can hardly obscure that few. By using a picture of the long-haul-to-a-not-so-rosy-future for U.S. inflation, and contrasting it with a picture to represent Japan's declining rate, I'm making an image that will be remembered longer than a pair of simple crossing lines. These statistics present a recurrent problem for picto-chartists: How do you represent something that's going down, as good and up, as bad, when all one's in-built notions of these things are just the opposite?



8. The essential concept illustrated by the data in both of these graphs is crime, but in the top graph, the largest bar represents the city with the least crime! The "more is more" principle is virtually sacrosanct in information graphics, and the bottom graph follows it successfully. Most data can be reworked to ensure that the larger number accompanies the largest symbol.