Designer's Guide to Creating Charts & Diagrams

by Nigel Holmes
of Time Magazine

Acknowledgments

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Finally, thank you, Laurie, for allowing me the selfish indulgence of spending most of my waking time drawing charts and all the rest of it writing this book about them. You looked after me, and I couldn't have done it without you.

Preface

WE ARE DELUGED by a daily surge of figures: stock market figures, budget figures, deficit figures, population trends, increasing traffic trends, falling currency rates. In America every year:

The average person eats 81½ hot dogs and drinks 40 gallons of soda.

1.6 billion cigarettes are smoked.

There are 42 million pet cats.

The U.S. government is spending money at the rate of $23,000 a second.

How do we cope with them? Too many of us are scared by figures. We do not understand them. We would rather not look at them. We would like someone to explain them to us. Except to the trained few, figures are so anonymous, so flat, so obscure, and yet at the same time so threatening, as though they hide some secret that, if only we could see it, would reveal the horrible or wonderful truth of their subject.

The chartmaker can unlock the secrets of the figures. He or she can make their meaning visible, literally.

A simple chart is no more than a set of statistics made visible. It shows what has happened in the past and what might happen in the future.

But it can do more as well. It can engage the viewer by capturing his or her imagination. It can interpret the figures as well as present them. In fact, to simply parade the numbers as a set of bars or a rising and falling line does only half the job. It gives no clue as to the subject being dealt with. In certain contexts it might be perfectly proper to display the figures without any other visual help, but soon the charts will all look the same and therefore fail to be helpful, losing the interest of the consumer in much the same way as the bald figures themselves did before.

The purpose then of this book is to show:

That the role of the chartmaker can be greater than he or she ever thought.

That the job need not be boring, plodding plotting, but instead an enlightened experience for himself and those who use the work.

That those in a position to commission graphs, charts, and diagrams might expect more from their artists and might even be surprised by the results. They might laugh at the results. And thereby remember the salient facts.

That those about to hire an artist to work in this field might interview a mind first and a craftsman with a specific skill later.

That a writer might understand he or she is not losing precious lines of delicious prose to some unnecessary graphic, but instead be pleased that the attractiveness of the illustration will lead the viewer into reading the words. In the process he or she will be free to write unhindered by the statistics which are necessary for the argument but which get in the way of the article's flow.

The way some of this can be achieved is by joining together mathematics and illustration while keeping the statistics—the very reason for the existence of the chart—uppermost in the mind. The skillful chartmaker should attempt to find a suitable visual vehicle into which the facts can be placed. At the least this would be a background or frame for an otherwise perfectly conventional chart or graph, and at best it would be a marriage of statistics and illustrations, where the figures are present and the form they are displayed in reveal their subject.

The artist undertaking this task of welding together fact and picture should be prepared with arguments and reasons for so doing. He or she will not have an easy ride. He will be thought of as trivializing the nature of the figures he is portraying. He will be challenged on the correctness of the image chosen to accompany the figures; he will be questioned about why such an image is needed at all. His charts must speak for themselves of course, but he will also have to back them up with reasons at first, until he has won the confidence of client, editor, or reader. And having won that trust, he must be equally prepared to argue against the use of pictorial elements, for there are times when it will be more appropriate to do without them.

In short, the chartmaker should take charge of the situation as best he or she can under the particular circumstances, take the job seriously, and fully realize the potential of it.

Are you a magazine editor hoping to inform your readers of the history and present state of unemployment?

Are you a newspaper reporter working on a profile of crime in your city?

Are you a corporate V.P. in charge of your company's annual report that needs to show the breakdown of income and spending?

Do you work in the State Budget Office and have to prepare a large chart to show at a press conference and later at a meeting of interested citizen groups?

As an architect or designer, do you have to show your client the details of the costs of your plan for them? Or do you have to present a step-by-step guide to show how each segment of the construction of their office block will be dovetailed so that the night workers are on-site at the right time? Or must you show why the offices are so configured as to facilitate the flow of work required by the employers?

Do you publish a newsletter on oil and gas? Perhaps you need to show what steps increase the price of crude oil from the ground in Saudi Arabia through its journey to the gas you buy for your car?

Are you a management consultant who must demonstrate a more efficient working method for a company?

Do you need to show trends in infant mortality for a UNICEF exhibition traveling to junior high schools around the country? Or on an around-the-world trip, including places where no English is spoken? Or to university-level audiences?

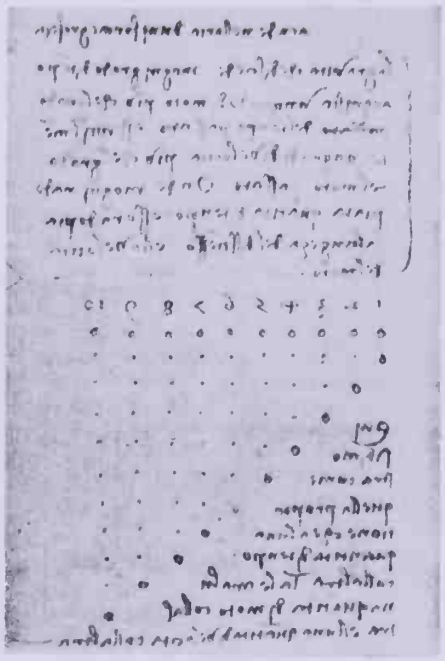
Do you need a raise and feel that your situation would be better understood if presented graphically to your boss?

Are you preparing coverage of the elections for a local cable TV network?

Are you the President of the United States about to face the nation with unpopular but necessary budget proposals?

If you answered "yes" to any of these questions, this book will help you.

Chapter One
The Chart Starts Here



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Leonardo da Vinci plotted the fall of an object through space and time. His habit of writing everything from the left (top) is translated into modern type the more conventional way (bottom).

NO ONE THOUGHT much about charts before Roger Bacon came along. True, the first calendar of 365 days was invented by the Egyptians sometime between 2800 and 2600 B.C., Aristotle applied systematic thinking to science in 350 B.C., the Chinese invented paper in 100 A.D. and abacus calculators around 570, the Japanese printed from blocks with raised surfaces in the 8th century, and without these steps charts could never have been drawn. But only on Bacon's urging that mathematics be learned at universities did a means by which to study measurements begin. The work of this English scientist, who lived from 1214 to 1294, provided the impetus and inspiration that led, ultimately, to the science of visualizing abstract statistics—or charts.

Whereas astronomy had its own practical traditions of observation and measurement, there was no procedure for taking measurements connected with mechanics and physics, and thus those sciences developed along a theoretical path only. Important work in the early part of the 14th century was done in Oxford by Thomas Bradwardine, who used algebraic letters and symbols and laid the foundation for the next natural step—representing one function and its relation to another function by the use of graphs.

At about the same time in Paris, Albert of Saxony, Marsilius of Inghen, and, most importantly, Nicole d' Oresme, Bishop of Lisieux (1325–1382) discovered the logical equivalence between the organization of figures into groups and the graphing of those figures. Oresme himself produced the earliest graphs.

In 1465 the printing press first appeared in Italy. Although there is no direct evidence that Leonardo da Vinci (1452–1519) actually read the largely theoretical works of these early mathematicians from Oxford and Paris, the influence and traditions of their theories must have had a profound effect on him. In his notebooks Leonardo made one of the earliest versions of graphic representation. It plots a falling body against a time frame.

Since Leonardo wrote everything reversed from left to right I have set his graph the correct way round in modern type. Attached to the original is a note that reads, "Here is shown how such a proportion as one quantity of time and another will have a quantity of movement with the other, and a quantity of speed with the other."

DESCARTES' CONTRIBUTION

Later René Descartes (1596–1650) began to develop a systematic basis for this kind of thinking. In a 106-page footnote to his book *Discourse on the Method of Rightly Conducting the Reason and Seeking Truth in the Sciences* (published in 1637, 18 years after his original inspirational dream on November 10, 1619), Descartes outlined his "analytic geometry." This mere addendum to his philosophical theories was eventually to become the work that established him as more important in the field of science and mathematics than in that of philosophy. Analytic geometry had as its basis the idea that two numbers can describe the position of a point on a surface. He used two lines with scales marked on them called "coordinates"; the numbers were one of the points on the scale along each line. One of the lines was a distance measured horizontally, the other a distance measured vertically. Descartes' concept of a graph, using a grid of criss-crossing straight lines to describe a surface, was the forerunner of today's graph paper. His system of intersecting lines or coordinates is known as the "Cartesian grid." The original horizontal line is the x axis (or abscissa) and is the base line of the graph. The vertical line is the y axis (or ordinate).

Descartes' approach to geometry gave mathematicians a new way to look at equations, and is the basis of plotting statistics that we use today in charts and graphs.

PLAYFAIR LED THE WAY

John Playfair (1748–1819), a Scottish mathematician and a professor of maths (1785–1805) and natural philosophy (1805–1819) at the University of Edinburgh, noted in his *Progress of Natural Philosophy* that "it is seldom the destination of nature that a new discovery should be begun and perfected by the same individual and, in these attempts, though Descartes did not entirely fail, he cannot be considered as having been successful." Sir Isaac Newton and Gottfried Liebnitz separately furthered Descartes' theories of coordinates with reference to mathematical questions.

At about the same time as John Playfair was writing his theories his younger brother William was inventing the application of charts and graphs to financial statistics. Because he was determined to become an author, he dismissed his early training and associations with those involved in engineering and other practical sciences and thus did not achieve the eminence he deserved. What is more, he was extremely opinionated and held controversial ideas about government and reform, which he pressed on others. He thus fell into the gap between writer and scientist and was recognized as neither: The scientists of his day did not recognize his inventions, nor the literary set his writing. He is almost unknown today.

William Playfair was born near Dundee, Scotland, in 1759 and was apprenticed as a teenager to Andrew Meikle, the inventor of the threshing machine. Later he became highly skilled at technical drawing, developed while working with Boulton & Watt, the engineering firm, in Birmingham, England. This technical background obviously contributed to his discovery of graphic methods of charting.

When he was 25 in 1786, he published the *Commercial & Political Atlas*.* It contains the first types of chart he perfected, the fever or line graph and the bar chart. There were forty-four charts in the "atlas," about half of them hand-colored copper-plate engravings representing trade between England and other countries. Playfair also included tables of the figures he was charting—"the mode here adopted for conveying information is accurate in its principle though in the execution

*In two later editions, in 1787 and 1801, the information in the original was updated.

it may be liable sometimes to error. I have however spared no pains to avoid mistakes and have added printed tables."

Playfair explains his method: "If the money received by a man in trade were all in guineas, and every evening he made a single pile of all the guineas received during the day, each pile would represent a day, and its height proportioned to the receipts of that day; so that by this plain operation, time, proportion and amount would all be physically combined. 'Lineal Arithmetic' then, it may be averred, is nothing more than those piles of guineas represented on paper, and on a small scale, in which an inch perhaps represents the thickness of five million guineas. As in geography it does the breadth of a river, or any other extent of the country. By this method as much information may be obtained in five minutes as would require whole days to imprint on the memory . . . by a table of figures."

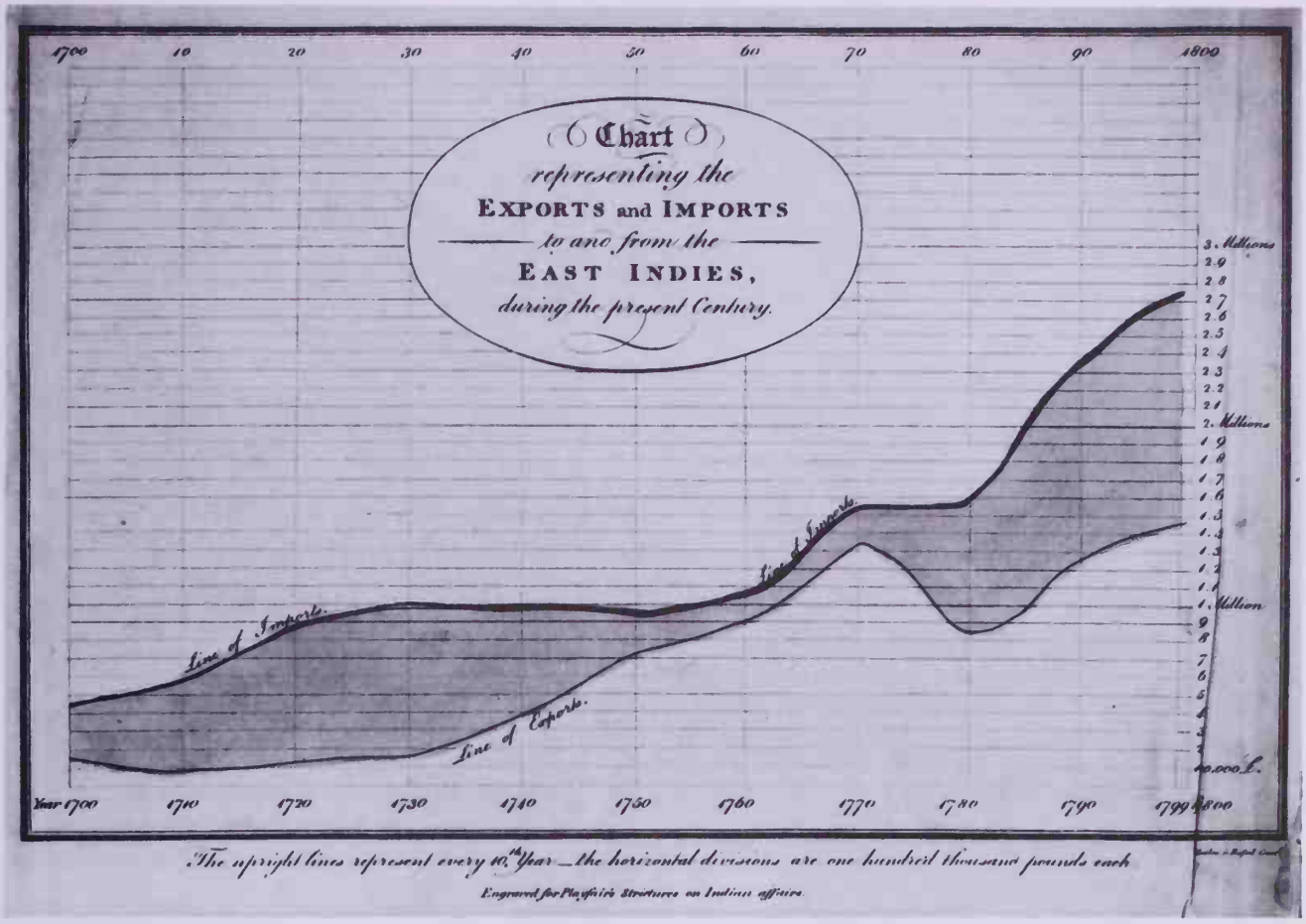
He further points out that "The advantage proposed by those charts, is not that of giving a more accurate statement than by figures, but it is to give a more simple and permanent idea of the gradual progress and comparative amounts, at different periods, by presenting to the eye a figure, the proportions of which correspond with the amount of the sums intended to be expressed."

Playfair generally accompanied his charts with lengthy descriptions to underline the points being made. They were often used as visual evidence in a case he was championing. For instance, he wrote to the two Houses of Parliament about "our agricultural distresses, their causes and remedies, accompanied with tables and copper-plate charts, shewing and comparing the price of wheat, bread and labour, from 1565 to 1821" (published in London in 1821).

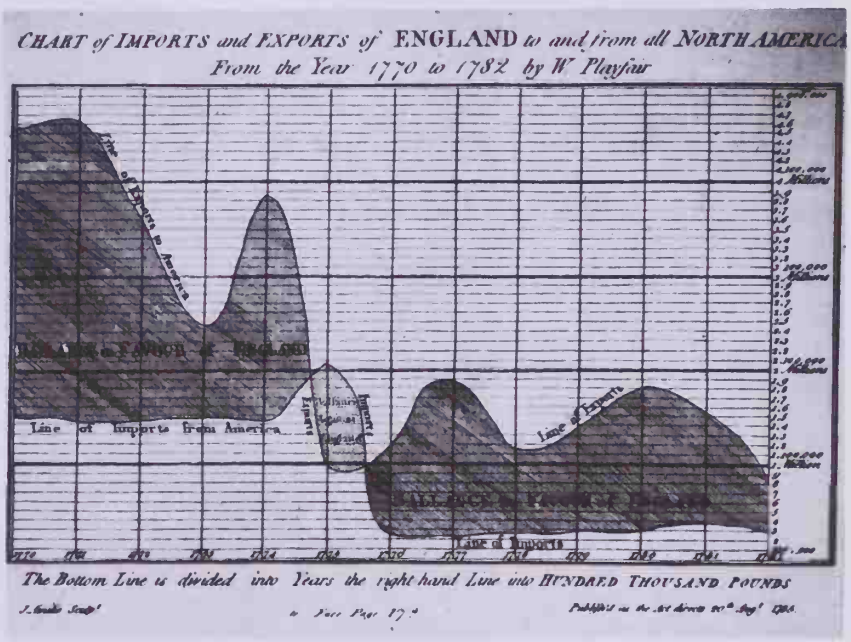
He charted the effect that wars had on Britain's national debts, showing very clearly by means of a fever chart, which he shaded in from the plotted line to the base, that the debt leapt up during the war periods. All Playfair's work was most carefully and methodically annotated, which today is not so necessary as it was when his charts first appeared before a public unaccustomed to reading anything like them. The national debt chart, for instance, has the note, "The Divisions at the Bottom are Years and those on the Right hand, Money." Every year from 1688 to 1784 is marked with a neat tick and every million pounds marked on the vertical scale from 0 to 300. And he added in an introduction to *An Inquiry into the Causes of the Decline and Fall of Powerful & Wealthy Nations* (1805), "the reader will find 5 minutes attention to the principle on which the charts are constructed a saving of much labour and time; but without that trifling attention, he may as well look at a blank sheet of paper as at one of the charts."

A French edition of the atlas published in 1789 was a great success. It is interesting to note that it was the French 400 years earlier who had taken some of the first steps toward graphic representations and who now were developing Playfair's inventions. For it was in France that much of the next century's graphic activity took place. Perhaps because Playfair himself underestimated the importance of his graphic work in favor of his writing, he did not further his own inventions (though there is evidence he was pleased by the reception they had in France). This is a pity since he seems to have been eminently qualified to be the forerunner of today's graphic journalist, coupling writing and drafting skills with a keen mind, open to seeing how groups of different statistics, when combined, could make a very telling point. He moved to France in 1787, but his political views and writings, especially attacks on the Constitution in 1789, led to his having to leave in 1792.

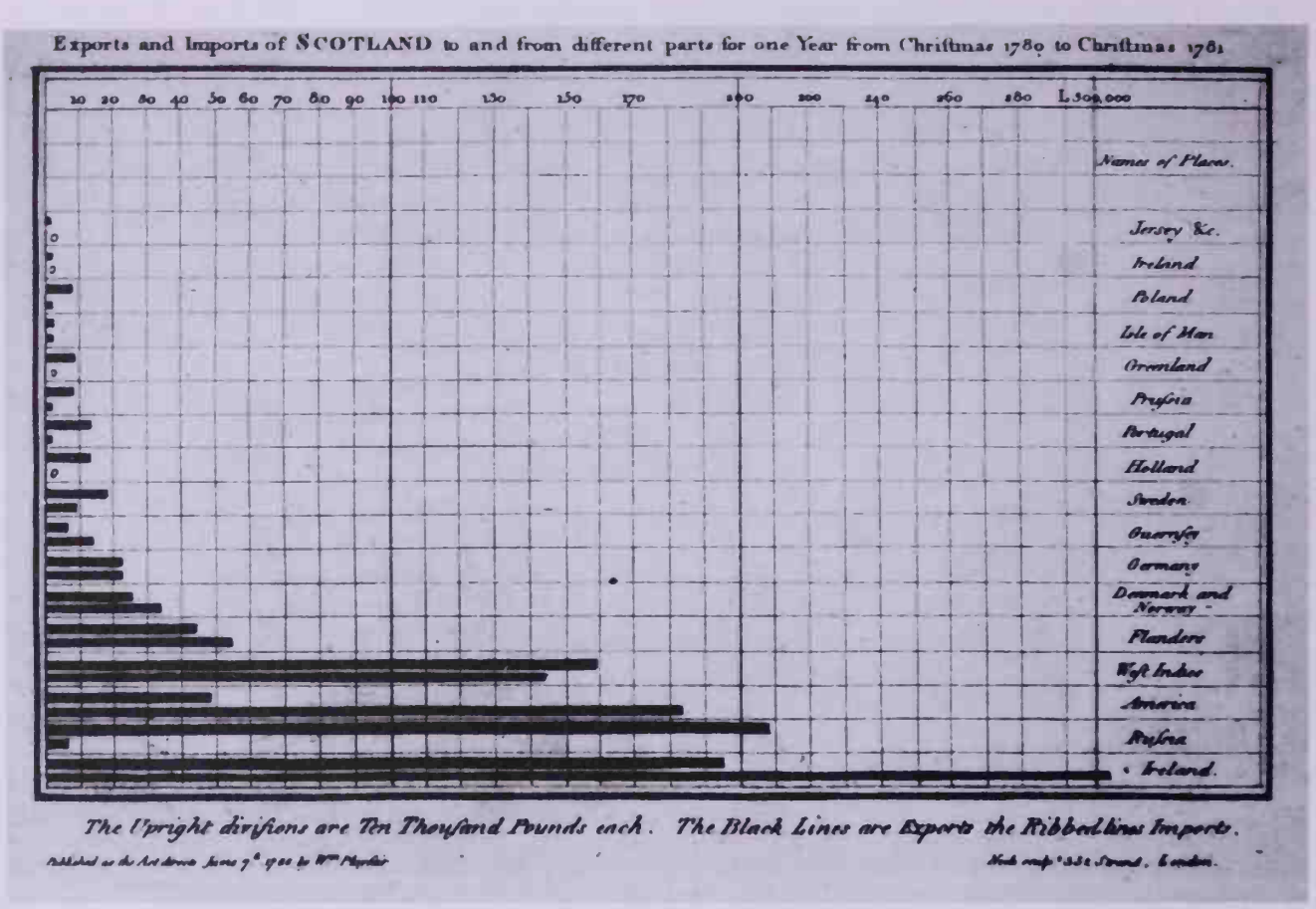
What of the people who saw his charts? His titling of the pieces with a large, bold, and often decoratively treated inscriptions is perhaps his



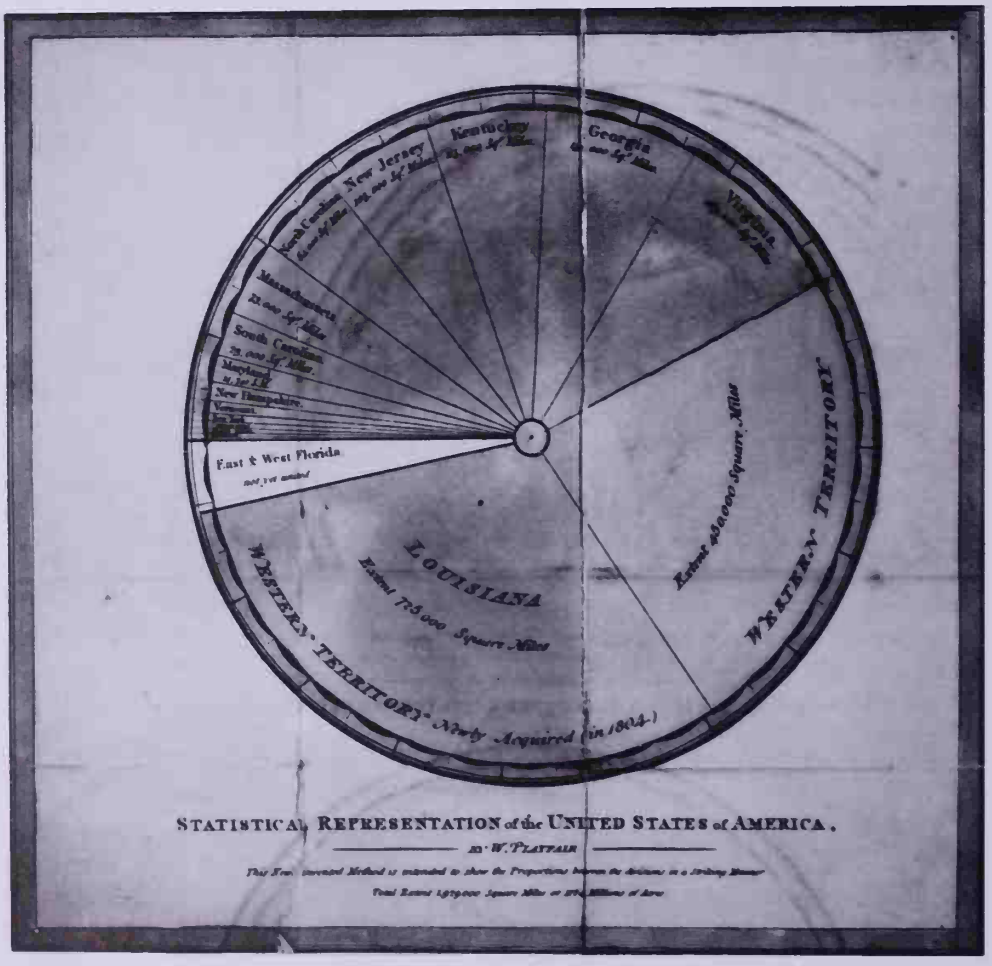
The first use of fever charts was by William Playfair at the end of the 18th century. (Above) This chart represents the exports and imports to and from the East Indies between 1700 and 1799. Hand-colored, it is accompanied by an explanation of how to read the information and a warning that these are generalized graph lines that can never be as specific as a table of figures. From An Inquiry into the Causes of the Decline and Fall of Powerful and Wealthy Nations.



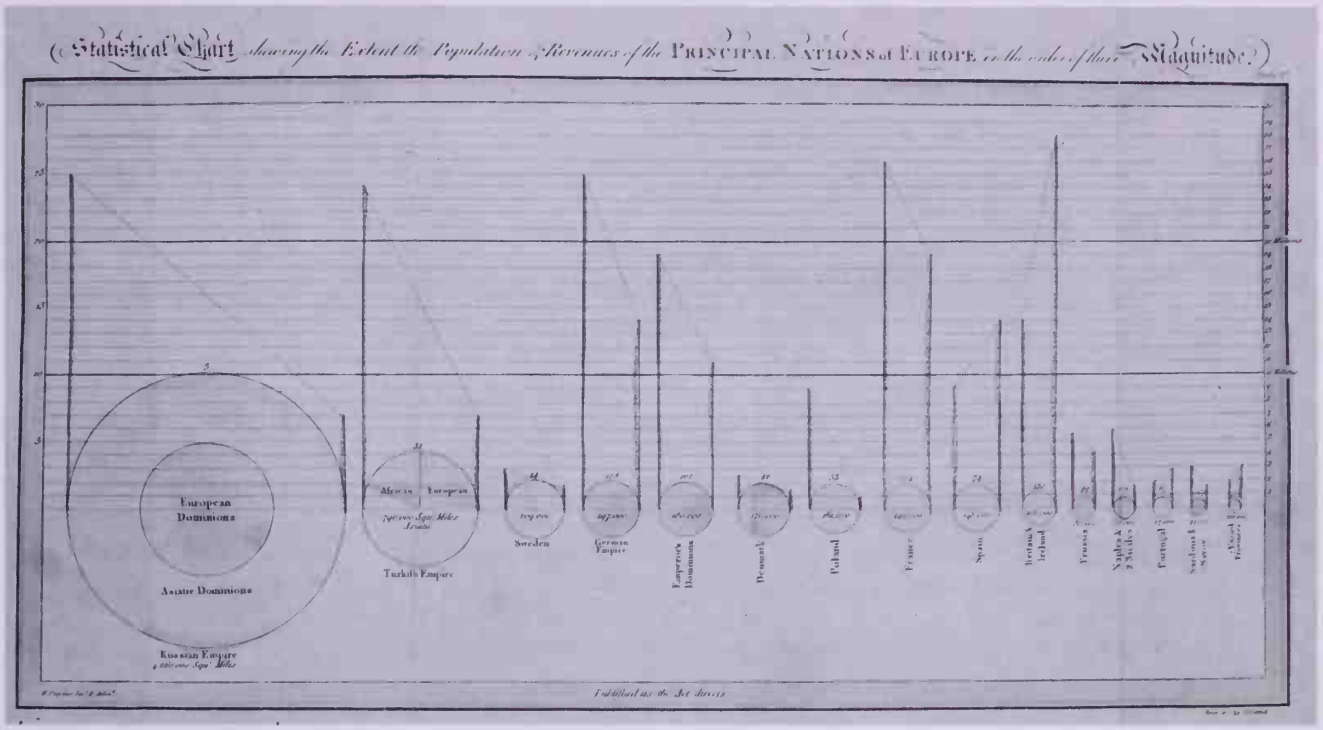
(Right) Playfair's chart showing English imports and exports to and from all North America was first published in 1785 in his Commercial and Political Atlas *and showed how the balance of trade changed from being "in favour of England" at the left, to "against England" for a period during 1774–1775, then back to the original situation for the rest of the timespan. This uncolored version is from the second edition of the book, published in 1787. With only a slight sophistication in the use of type, charts are still drawn like this today. Playfair's original ideas have remained the basis for all modern chartmaking.*



A bar chart showing Scotland's imports and exports from the Commercial and Political Atlas *(second edition, 1787). The bar is the only form of statistical presentation that Playfair used but did not invent. Here horizontal bars are grouped in twos, the upper "ribbed" (cross-hatched) bars representing imports and the lower black lines representing exports.*

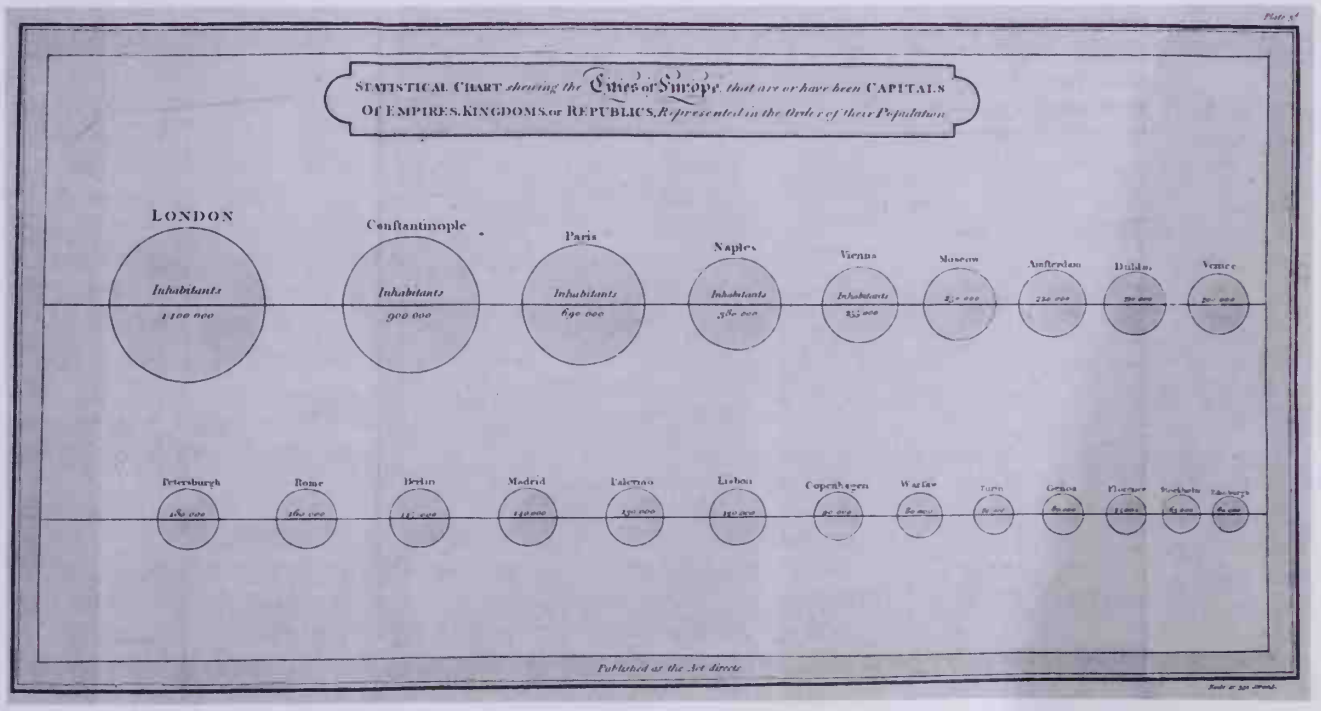


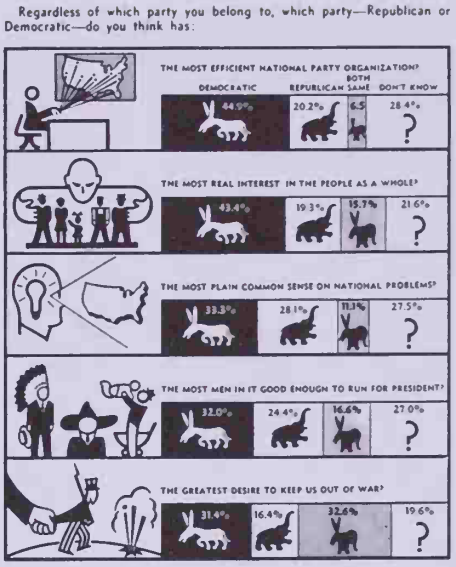
In 1805 Playfair published the first pie chart, in the Statistical Account of the United States of America. *It is delicately colored by hand, in washes of light blue, green, and pink and shows proportional divisions of the United States at that time. The principle of the pie chart, which he called a "divided circle," is the same today as it was when Playfair invented it.*



(Above) In 1801 Playfair produced the Statistical Breviary, *in which this chart appeared. His name for it was "circle graph." There is an enormous amount of data contained in this piece. The size of each circle is in proportion to the area of the nation it represents, with the uprights standing for population on the left and revenues on the right. Playfair mistakenly draws a conclusion from the slope of the line joining these two uprights. This slope of course depends as much on the width of the circle as on the height of the uprights to produce its angle.*

(Below) Also from the Statistical Breviary *is this diagram of European cities ranked in order of their population. It is interesting to note that in 1805 London's population was 2,300,000 compared with Moscow with 250,000. Present-day figures are London, 6,700,000, and Moscow, 8,200,000. New York City went from 50,000 to 7,000,000 in the same time.*





Fortune *was one of the first mass-circulation magazines to use illustrated charts. This divided bar chart from 1939 looks as fresh today as it must have then.*

version of the man with the red flag who walked in front of the first motor cars, warning the unsuspecting pedestrians of what was to come. We take the form for granted today and look for the story; in the 18th century the form was new. It has changed very little since then, but now we recognize it and do not need the red flag.

With the publication in 1801 of his *Statistical Breviary* Playfair introduced the circle chart, a form that is hard to use without distortion but that is nevertheless interesting and worthy of note. The size of each circle is proportionate to the area of a country. Two lines rise from the edges of the circle. That on the left measures the population of the country, on the right the revenue. Playfair makes the mistake of joining up the two with a diagonal line and suggests that this represents the tax burden. The slope of course depends not only on the height of the two bars that it joins, but also on the diameter of the circle.

1805 saw the publication of another of Playfair's chart inventions: the "divided circle." Nowadays we would call it a "pie chart." He translated into English "The Statistical Account of the United States of America" by the French statistician D. F. Donnant and added his own illustration, a chart "representing the proportional extent of the different states of the Eastern Country and the newly acquired territory of Louisiana." The pie chart was inscribed: "This newly invented method is intended to shew the proportions in a striking manner." He sent the book to Thomas Jefferson and asked that the President use the blank pages which he had intentionally bound into the volume to add his comments and alterations to any of the facts that were out of date or wrong. It was filled with statistics: In 1803, for instance, an individual could defray his year's taxes with two day's work. (In the 1980s the period had grown to five months.) In the same year America exported to England 2½ million pounds of cheese (I hope it was not called swiss or cheddar then!) and 1 million pounds of tallow candles. None of Playfair's books or other writing records whether Jefferson replied.

Although Playfair can be credited with the invention of the modern methods of visualizing facts and figures he himself admits to a considerable influence from his brother. In the *Decline & Fall* of 1805 he acknowledges that "At a very early period of my life, my brother, who, in a most exemplary manner, maintained and educated the family his father left, made me keep a register of a thermometer, expressing the variations by lines on a divided scale. He taught me to know that, whatever can be expressed in numbers may be represented by lines."

One final note: A close inspection of his originals show that the "lines" are clearly "drawn" rather than "plotted" by joining up one point to another, and then another, and so on. Whether a preliminary sketch was made before the final engravings is not mentioned in any of the many notes, introductions, and descriptions that he wrote. Perhaps in the case of some early figures, as he admits "the materials (figures) . . . are not altogether accurate," he took the smoothed-out line that had to be used in those cases and continued it even though some of the rest of the chart may not have been well substantiated with statistics.

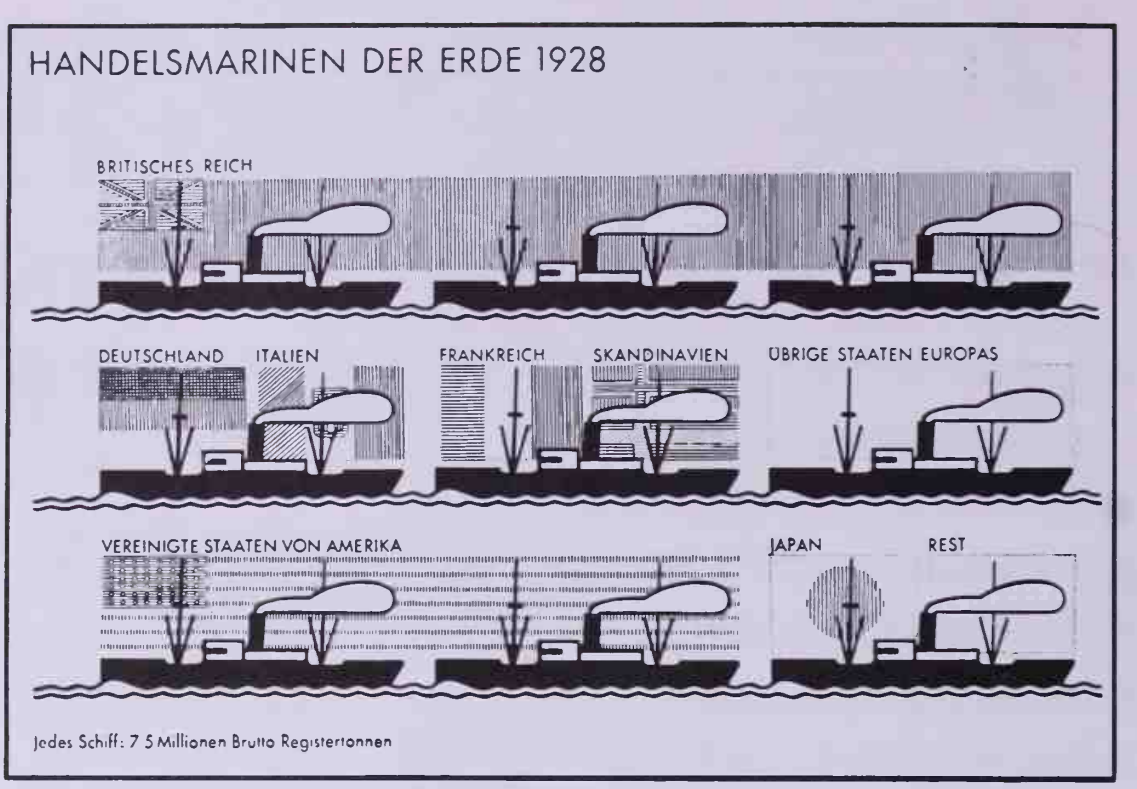
Playfair died in 1823.

Not the least remarkable thing about Playfair's work was that he was charting statistics at a time when there were few such facts and figures being collected in an organized way.

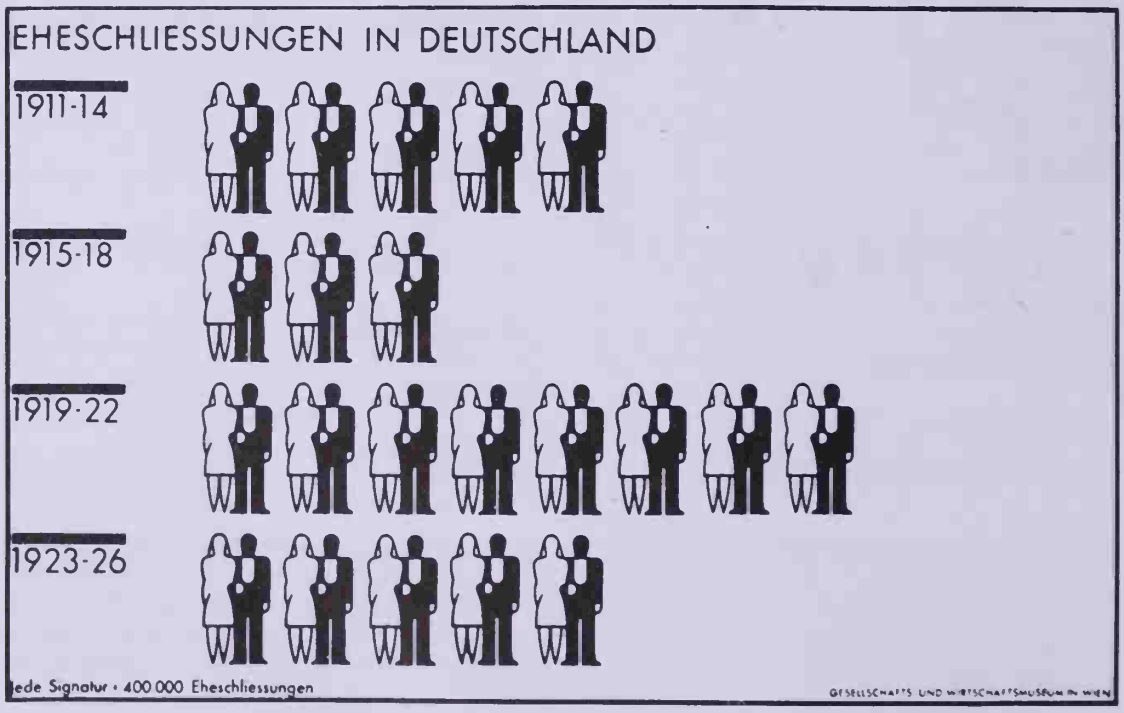
QUETELET CREATES THE NEW SCIENCE OF STATISTICS

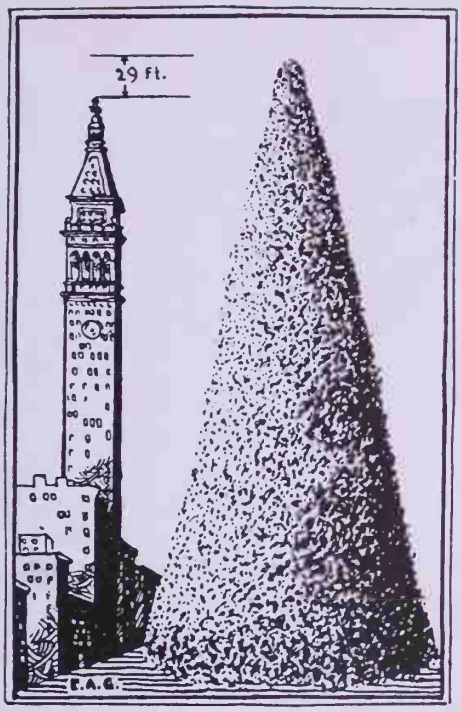
The man who was recognized as the creator of the new science of statistics was Jacques Quételet (1796–1874). An office of statistics was set up in 1826 to take a census of what was then The Netherlands. In 1832 after the revolution, Quételet was asked to help, and the results of the population census of Belgium were published. He was made the

A whole page of charts from Fortune, *incorporating divided bars and ordinary bar charts, makes wonderful use of really inventive little symbols. The simplicity of the welcoming or shunning hands in the two charts at bottom right is graphically elegant and full of information. Modern chartmakers could learn a lot from the excellent use of blacks and whites in this example from almost 50 years ago.*



Two charts from Otto Neurath's Vienna Museum of Social and Economic Studies: (below) marriages in Germany from 1911–1926 and (above) the world's merchant fleets in 1928. It was Neurath's aim to give information visually so that anyone could understand it regardless of language or culture. He devised a picture language called "Isotype" (International System of Typographic Picture Education) and applied its rules rigorously to his work. The symbols (or isotypes) produced as part of the so-called Vienna Method of representation remain models of simplification and have exerted a very strong influence on chartmakers from their invention in the 1920s to today.





A pictorial bar chart comparing a year's worth of New York City waste (1922) to the height of the Woolworth Building (which was 29 feet higher). The obvious difficulty of determining how big an area on the ground should be covered by the base of the pile before it started rising (which could have resulted in a much higher pile had the ground area been smaller) is far outweighed by the visual impact of the idea.

President of the "Central Commission of Statistics" in 1841, and after much preparation he initiated the first international Congress of Statistics, which opened in Brussels on September 19, 1853.

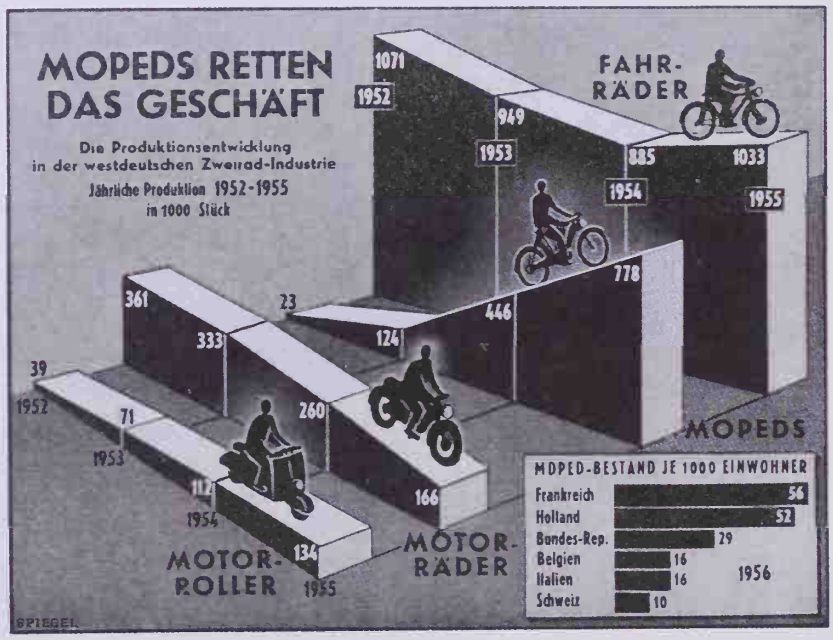
His biographer, Naum Reichesberg, of the University of Berne wrote in 1896 of Quételet: "This vast spirit has rendered tremendous services as a mathematician. . . . His name has been written in golden letters, particularly in the fields of sociology and statistics." Quételet's 65 books and major papers on the subject led Emile Levasseur of the College de France to hail him in 1872 as a scholar who "first contributed to making statistics a moral science."

In America, charting did not really catch on until the late 20s. After the Wall Street crash, people became interested in the possibility of predicting the ups and downs of the stock market, at least in general terms, by using the historical data shown in charts. Whether or not there could ever be any real accuracy in this "history-repeats-itself" thesis, it marked the beginning of the regular use of charts in American publications.

In Austria, under the pioneering direction of Dr. Otto Neurath, the Vienna Museum of Social and Economic Studies produced in the 20s charts of precision, clarity, and graphic excellence that are still models of "how-to-do-it" today. In a publication describing the museum's work it was said: "If the immense power of statistical truth is to be turned to full account the prime necessity is the pictorial representation of statistical data. Our museum, with its carefully evolved method, is able, graphically, to represent social and economic problems. Meaningless columns of figures spring to life. Logic wedded to clarity is effective and convincing."

The "Vienna method," as it came to be known, had very strict principles. All irrelevant, decorative elements were banned. Symbols were drawn with the utmost simplicity. Instead of showing an increase in the quantity of a commodity by increasing the size of its symbol, the symbol itself was repeated as many times as was necessary to be representative of the required amount. By and large the drawing of objects in three dimensions was also avoided so as not to give a false impression of the quantity in question.

The museum charted the size of the world's armies, its production figures, commerce, population, religion, culture, and many of the symbols created by Neurath and the museum's art director, Gerd Arntz, can still be seen in charts today, for they have never been bettered.



This example of three-dimensional fever charts from West Germany in the 1950s gives information clearly and with nice symbolic touches. More tonal in execution than any of the other examples in the brief historical survey of this chapter, it was a forerunner of the more illustrated charts developed in the 1970s.

Chapter Two
The Four Types

STATISTICS MAY BE presented graphically in many different ways, but there should always be a sound reason for choosing the particular form of presentation. There are only four basic types of chart—fever chart, bar chart, pie chart, and table—and one of them will be the right form for any type of statistical information you may wish to display.

By and large it is the material itself that will determine which kind is to be used, for it will naturally be visually clearer in that form than in any of the others. The purpose of making a chart is to clarify or make visible the facts that otherwise would lie buried in a mass of written material, lists, balance sheets, or reports.

The type of chart chosen must enlighten the reader/user/viewer. It must seem to be the natural way for the material to be shown.

Taking each type of chart in turn, this chapter will ask six important questions about each one and will discuss and illustrate the differences:

1. What is the definition of a fever, bar, pie, or table?
It is important to know the differences among the types so that the best one is chosen for the job in hand.

2. What are its main elements?
It is important to fully understand the parts of each type so they can be put to the best use.

3. What variants are there?
It is important to be able to expand the scope of your work by being able to use one of the varieties of the four main types. To cope with any statistical problems you should know what varieties of the four main types are available.

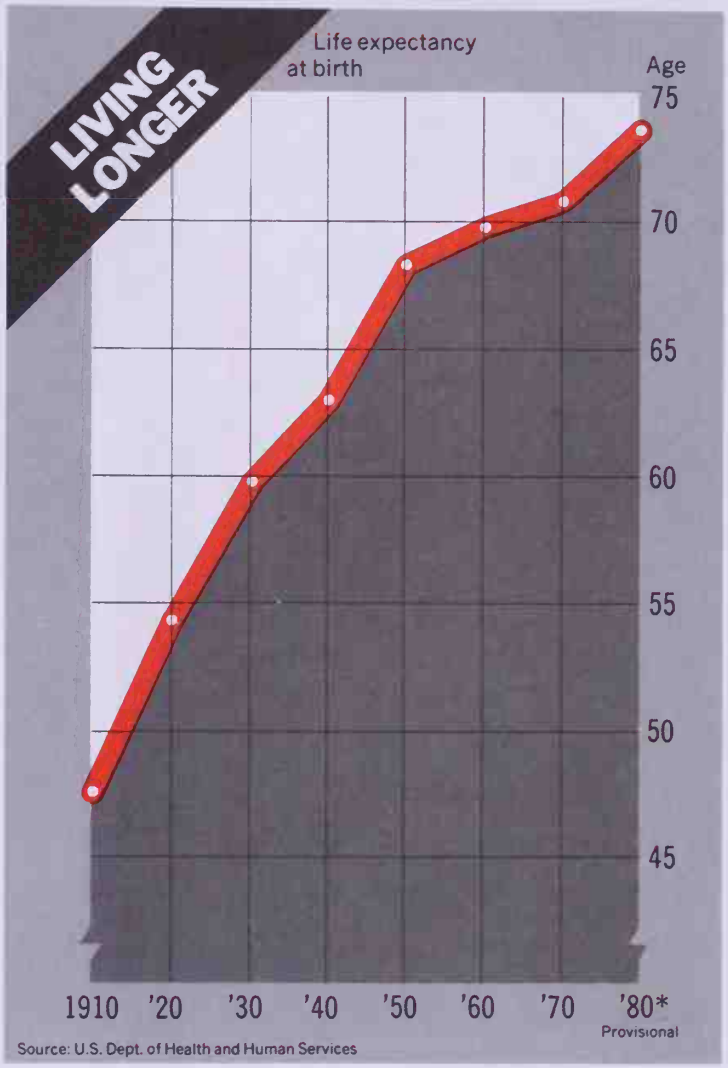
4. What are appropriate uses?
It is important to know when it is right to use a fever chart, when a bar chart, when a pie chart, and when a table, and why each is successful.

5. What are inappropriate uses?
It is important to know when the wrong form has been chosen and why it is therefore unsuccessful.

6. What are the main requirements?
It is important to know what materials are needed to produce the chart, how difficult it will be, how long it will take, and what additional services and personnel may be required.

On the next four pages, a single typical example of each type will be shown; then the four types will be discussed in detail.

TYPICAL FEVER CHART



1. Definition
Visualization of quantities, plotted over a time period, by means of a rising and falling line.

2. Main Elements
Fever line, produced by joining together points plotted on a grid. (Otherwise known as "the curve.")

Y axis (vertical scale) represents quantities.

X axis (horizontal scale) represents time.

3. Variants
Single line.

Multiple line.

Three-dimensional line.

Combination with other types of charts.

Photographic treatments.

Illustrative treatments.

4. Appropriate Uses
Unemployment figures, financial time series, stock indices, or any set of figures the flow of which needs to be shown over a period of time.

5. Inappropriate Uses
Information too close together statistically to distinguish among the lines.

Too little variation in quantities along a single line.

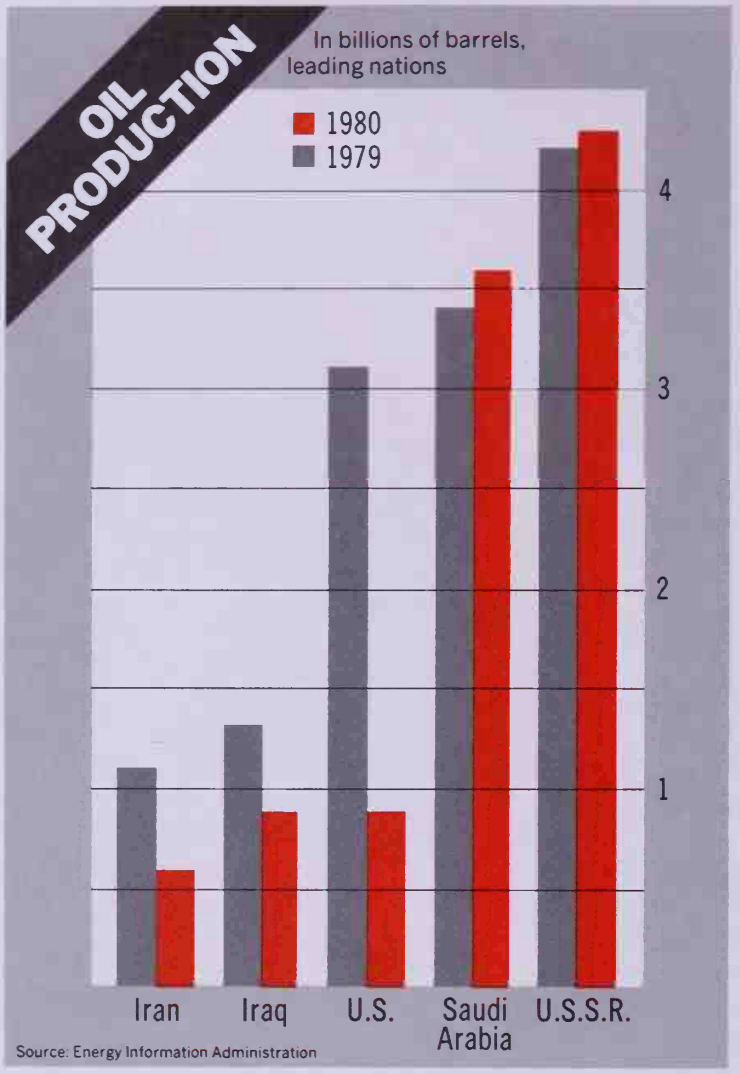
6. Requirements and Considerations
Easy to produce for a fast look at the flow of a set of figures.

Graph paper for initial plotting.

Colored pencils needed to distinguish lines of different figures.

Minimal typesetting.

TYPICAL BAR CHART



1. Definition
Visualization of quantities, each one represented by an individual bar or column corresponding in height or length to the amount being counted.

2. Main Elements
Bars, or elements grouped together in columns.

Grid, or a structural basis by which to understand the quantities.

3. Variants
Single row of abstract bars representing one commodity plotted over a time period.

Single row of abstract bars representing the values of different commodities all at the same time.

Three-dimensional versions of the above.

Bars as drawn representations of the commodity or subject described.

Small elements, each equivalent to one unit of the commodity being charted, graphically arranged into columns.

Multiple bars.

Double-ended bars: Both ends can be read against a scale.

4. Appropriate Uses
Prominence given to individual figures rather than to the overall flow.

Comparison of different commodities; not a time series.

To complement and show a difference between two or more sets of figures charted over the same time period.

5. Inappropriate Uses
Too many numbers, which would make the bars too thin.

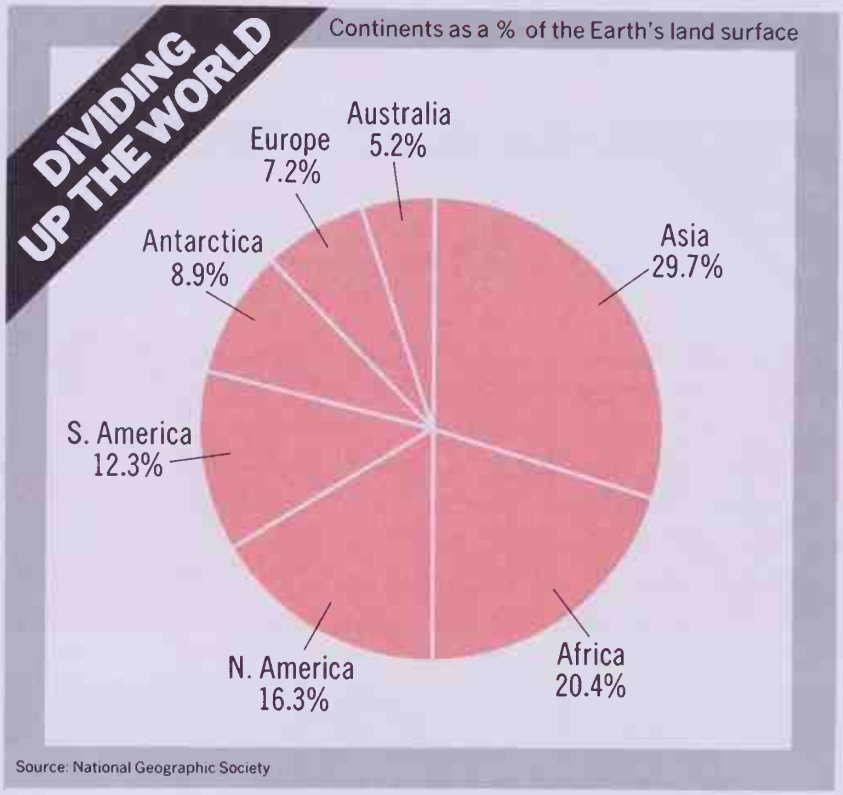
Where the "flow" is more important than the individual numbers.

6. Requirements and Considerations
Take longer than fever charts.

Must be ruled out neatly to be convincing.

Typesetting plays an important role especially when different commodities or subjects are involved.

TYPICAL PIE CHART



1. Definition
The division of a whole into its components, usually in percentages.

2. Main Elements
Circle representing the complete number divided up by "spokes" from the center.

Segments formed as the radiating spokes touch the circumference of the circle, standing for the parts of the whole.

3. Variants
Flat, abstract two-dimensional.

Abstract three-dimensional.

As an element in an illustration or with illustrative elements attached to it.

As a total illustration, not necessarily circular, but still divided into proportions.

Divided bar, abstract.

4. Appropriate Uses
To show up to eight or ten component parts of a whole.

Budgets, share of market figures, analysis of income and spending.

5. Inappropriate Uses
Too many divisions, leading to impossibly small slices of the pie.

Too complicated an overall shape if it is not a circle.

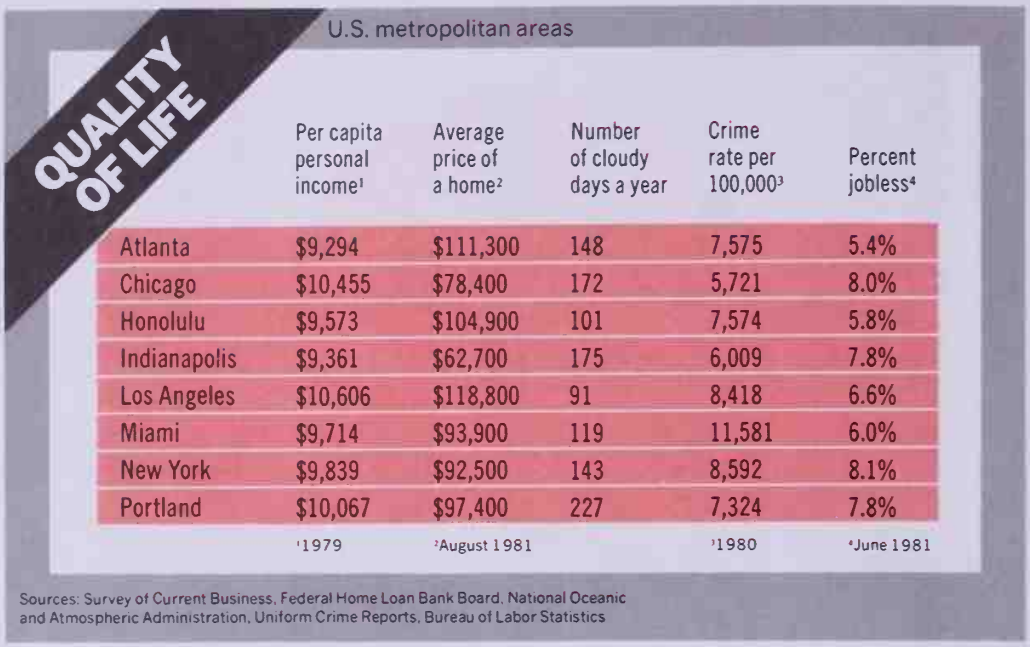
6. Requirements and Considerations
Easily and quickly recognizable form.

Can be used very small with great effect by color coding the segments.

Careful, consistent typography important.

Compass, protractor, and percentage wheel essential.

TYPICAL TABLE



QUALITY OF LIFE

U.S. metropolitan areas

	Per capita personal income[1]	Average price of a home[2]	Number of cloudy days a year	Crime rate per 100,000[3]	Percent jobless[4]
Atlanta	$9,294	$111,300	148	7,575	5.4%
Chicago	$10,455	$78,400	172	5,721	8.0%
Honolulu	$9,573	$104,900	101	7,574	5.8%
Indianapolis	$9,361	$62,700	175	6,009	7.8%
Los Angeles	$10,606	$118,800	91	8,418	6.6%
Miami	$9,714	$93,900	119	11,581	6.0%
New York	$9,839	$92,500	143	8,592	8.1%
Portland	$10,067	$97,400	227	7,324	7.8%
	[1]1979	[2]August 1981		[3]1980	[4]June 1981

Sources: Survey of Current Business, Federal Home Loan Bank Board, National Oceanic and Atmospheric Administration, Uniform Crime Reports, Bureau of Labor Statistics

1. Definition
Display of numbers or words arranged into columns.

2. Main Elements
The series of numbers and their subject titles.

A grid or framework to contain them.

3. Variants
Simple columns, with or without illustrations.

An illustrated frame that describes the subject matter.

A photographic background.

4. Appropriate Uses
Family trees, timetables, flow charts, distance/mileage charts, and calendars.

Comparisons of numbers that are too great in spread to be easily charted.

Where the exact numbers must be read, rather than illustrated as a generalized flow.

5. Inappropriate Uses
Where it is possible to plot the statistics as a chart. Don't miss the chance!

5. Requirements and Considerations
Type is very important: It is the main element and must be readable.

THE FEVER CHART

Together with the bar chart, the fever is the most often used form for the pictorial representation of statistics. The fever chart is particularly suitable for pinpointing accurately a given quantity on a given date, but it also shows the generalized trend in a set of statistics: that is, the "flow" of the figures in historical terms and an indication of the future, if projections or estimates are included. Much can be learned from the close study of a fever chart; indeed there are stock market analysts who specialize in future projections of stock performance based on such study.

The fever chart can best be understood by examining it in light of the six questions introduced at the beginning of this chapter.

1. What Is the Definition of a Fever Chart?

The fever chart is named after the piece of paper hanging on the end of a hospital patient's bed that traditionally plots his or her rising and falling temperature. Sometimes it is referred to as a "line graph."

It is a visualization of quantities, plotted over a period of time, with both the quantities and the time shown together. An example is the rising and falling of inflation over a period of years, or the change in the number of passengers on airlines.

2. What Are Its Main Elements?

First and foremost is the line from which this form gets its name. This is produced by joining together points plotted on two axes. In general the time period is plotted along the x, or horizontal, axis (abscissa), and the quantity being charted is plotted up (and down) the y, or vertical, axis (ordinate). The x and y axes are at right angles to one another. For complete accuracy in the reading of the fever chart, the line should be drawn by making a series of short straight lines from plot point to plot point. However, if the plot points are clearly marked (by small dots, for instance) the line joining them may be smoothed out, thus producing a more generalized "curve" that shows at a glance the direction and trend of the statistics being charted.

The horizontal scale is generally labeled at the bottom of the chart. So that there is no distortion of the information, the time divisions must be equally spaced along this axis, even if, at the time of plotting, information is not available for, say, each consecutive year. If some years are missing, there must nevertheless be a grid line for that year, and the fever line should be dotted or even left blank for that year only and should start again at the next year for which data are available.

The vertical scale, indicated along the y axis, usually represents a series of quantities or percentages of the subject being charted. As is the case with the horizontal scale, it is one of the grid lines and can be shown at either/or both sides of the chart as a slightly heavier line than the other grid lines.

The grid is formed by extending lines vertically or horizontally from the points at which the measurements from the horizontal and vertical axes are marked on their respective scales. If the graph is drawn on graph paper, all the lines are preprinted, and it is a question of deciding which of the lines already there are to be used. For the final production of the chart most of these lines will be omitted, so that the fever line itself stands out clearly. Just enough grid lines must be drawn to enable the reader to understand the information. But where only a quick general impression of the statistics is intended, the grid lines can be kept down to a minimum, and in some cases, only the horizontal and vertical scale lines, with their attendant numbers, are all that is needed.

The plot points mark the intersection of time and quantity on the grid and form the skeleton for the line itself.

Labels announce to the reader what the chart is about, denote the amounts and time period involved along the vertical and horizontal scales, and clarify the unit of measurement (for instance, where "unemployment" may be the subject of the chart, "percentage of civilian labor force unemployed at year-end" clarifies the unit of measurement). It is very important to provide essential details, such as whether part of the plotting is estimated or projected; to note the difference between lines, where more than one item is shown; and to give a source from which the original information was obtained. Although some of these labels will, and should, be small, they are nonetheless essential parts of a good chart, for without them the reader only gets part of the story.

If it is neater to do so, use an asterisk with a note at the bottom of the chart to clarify a point in the title or elsewhere. Sometimes a fuller explanation is needed than can be neatly fitted where it occurs on the chart. Labels ensure that the reader is left in no doubt about what any part of the chart means, and misleading or incomplete labels are just as annoying to a reader as misleading, incorrectly placed, or missing signposts are to the traveler wishing to find his or her way around an unknown area.

Color, when available, helps to differentiate lines in a multiple fever chart. Obviously, it can also liven up any, even the most simple, fever chart, but it should never be used for decorative purposes only.

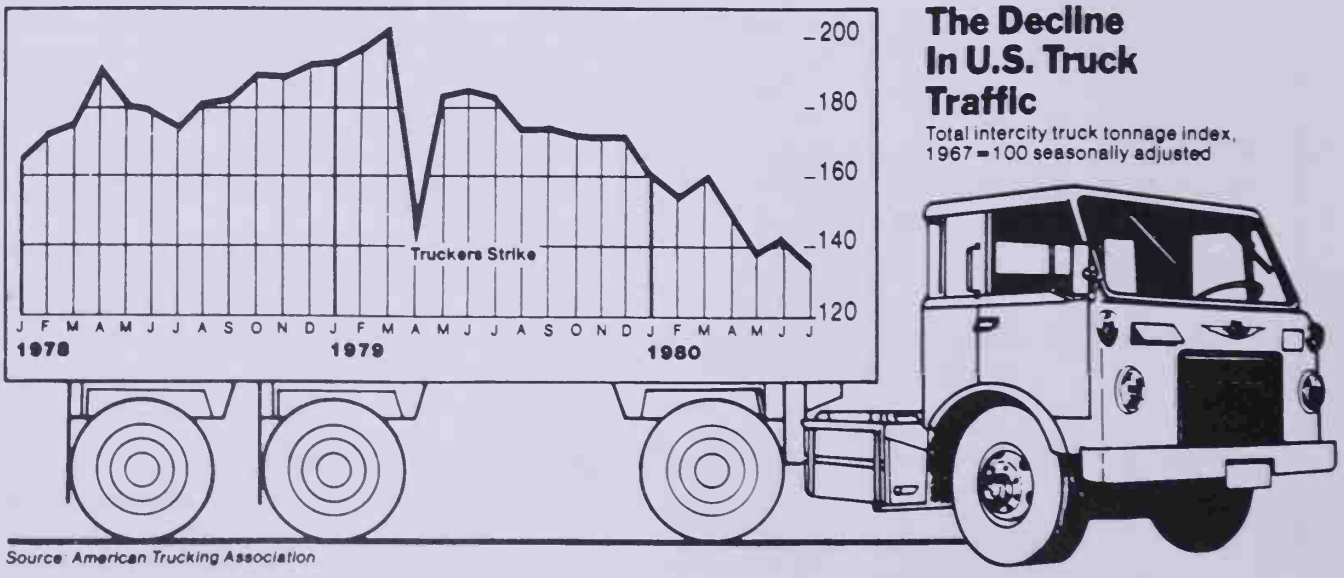
Where it is not possible because of lack of space to label each line separately in a multiple fever chart, a key should be used, showing a small sample of each type or color of line, with the appropriate description next to it.

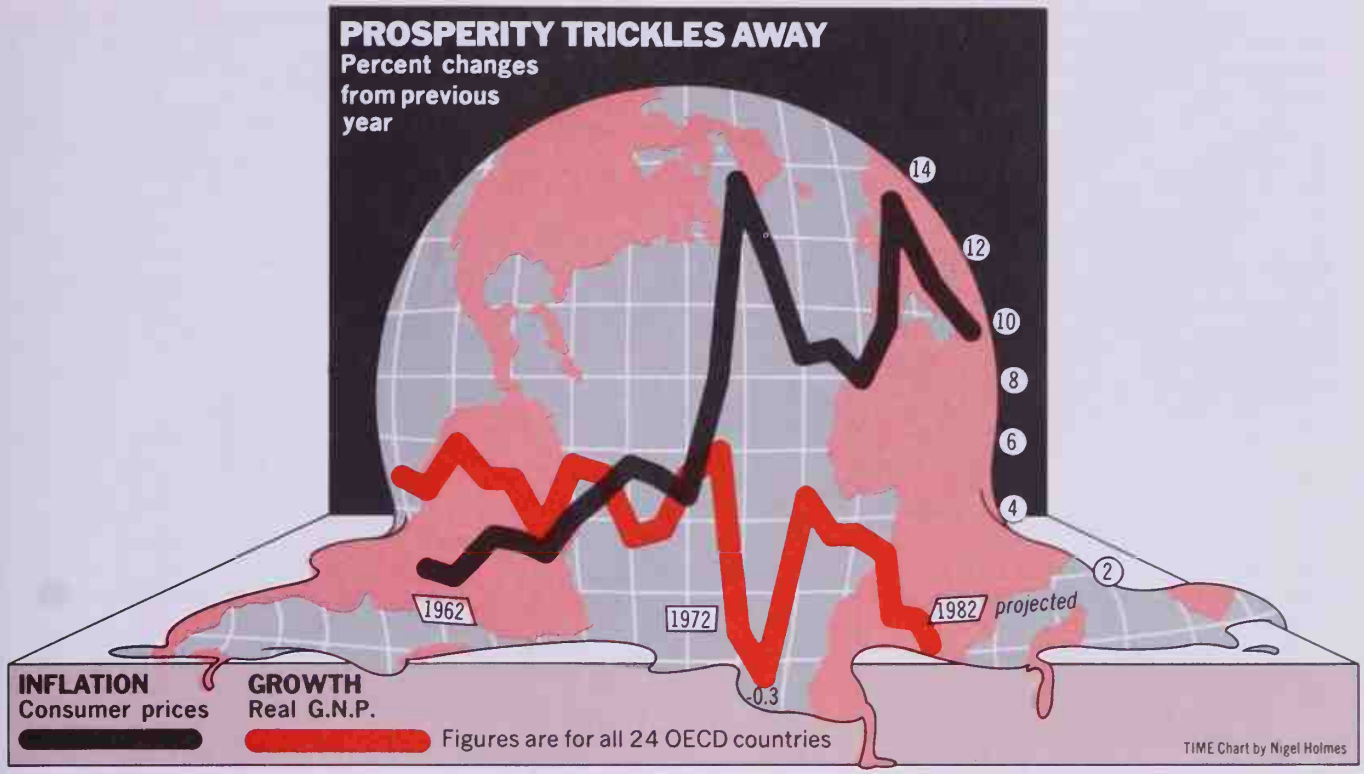
3. What Variants Are There?

The fever chart may take the form of one rising and falling graph line (the "curve"), or it may be a number of these lines standing for different subdivisions of the subject being graphed.

It may be projected into three dimensions and stand by itself as a solid shape, or it may be made into part of a picture (like a mountain range or a roller coaster). It might also be combined with another form of chart, for instance, the fever line tracking one batch of numbers and a bar chart another, both over the same period of time.

This graph of declining truck traffic is an example of a single line chart, with the grid showing above and/or below it. It is also called a "simple" line graph because a single set of values is connected by one line. The side of the truck is drawn parallel to the picture plane as a frame for the chart.

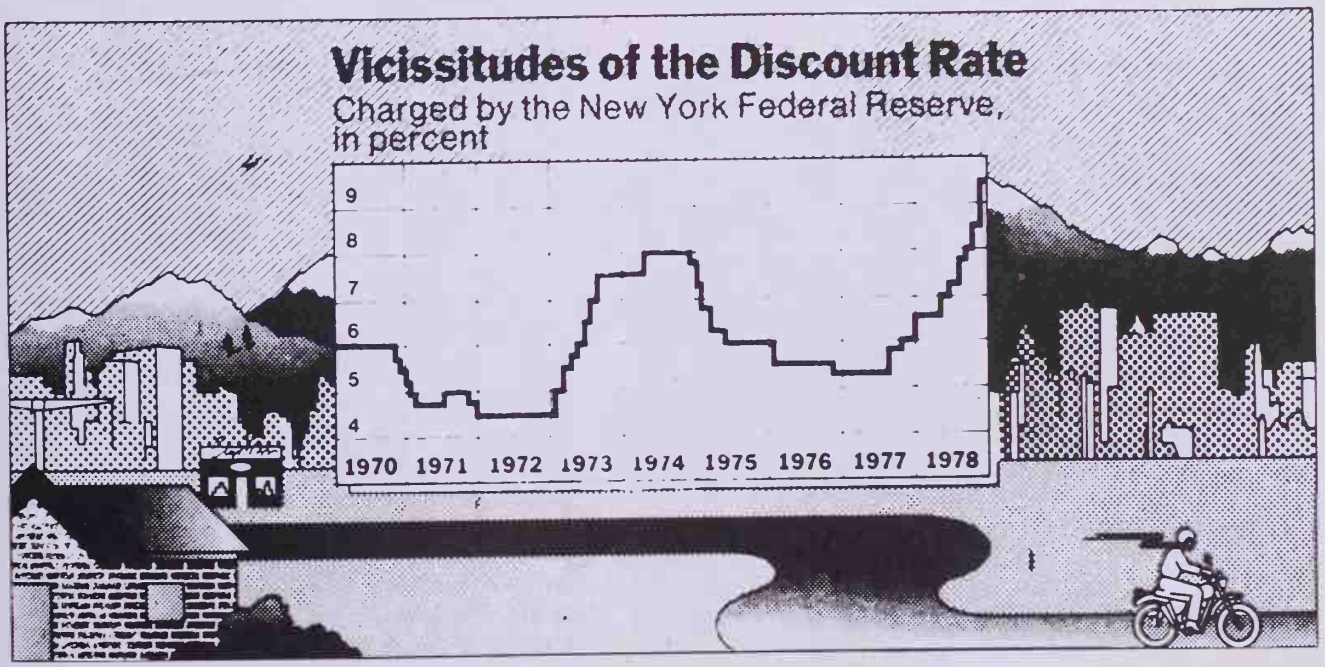




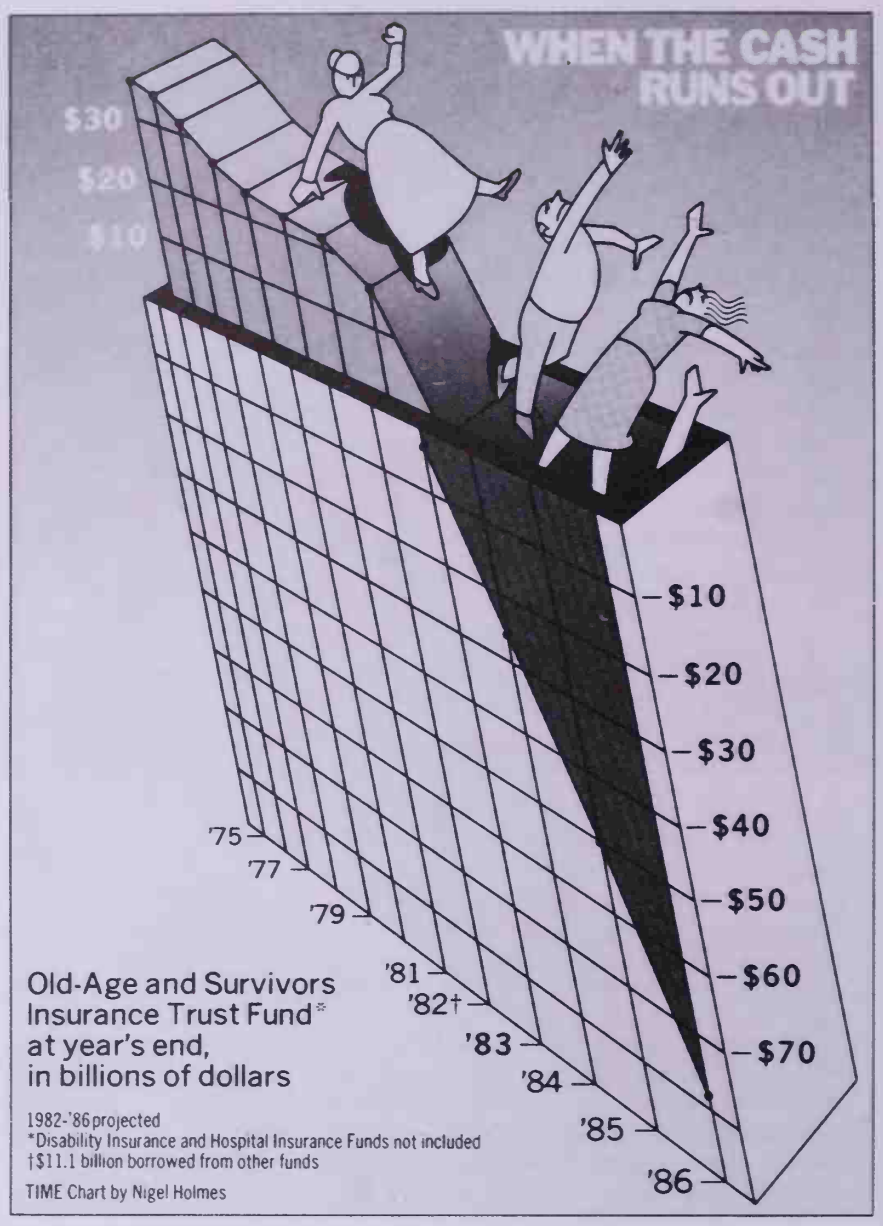
Multiple lines, each with its own set of values, are plotted on the same scale. Here inflation and growth are plotted together since they both fall within the same percentage range. Although they are different things, what is measured here is the percentage change from year to year in both of them, not actual quantities.

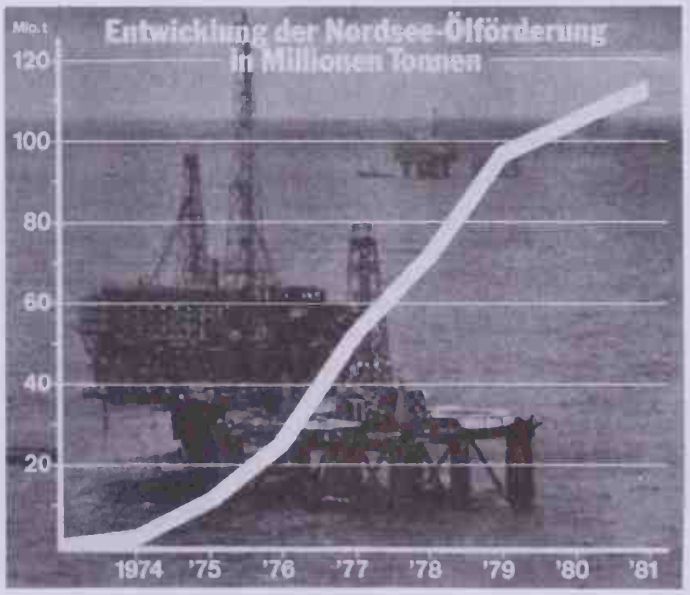
The grid lines do double duty here as conventional graph paper on which to plot the points and also as a reminder to the reader of longitude and latitude lines on the globe in the background. In this sense the globe is different from the truck in the chart on the opposite page, as it is both the background for the chart and an illustration of what the chart is about. The link is the grid lines, which naturally appear on graph paper and on a globe.

Note the stepped fever line. Certain interest rates (for example, the prime rate) are not adjusted monthly, but remain in force until the day a decision is made (by a majority of banks, in the case of the prime rate) to change them. On that date the rate changes up or down to a new rate and remains there until a new rate is decided upon. There is not necessarily any regularity to these changes, which accounts for the particular look of this variant of the fever chart.



Here the interaction of the humans with the otherwise abstract, three-dimensional fever chart illustrates the point that the numbers themselves make. The amount of cash available for Social Security payments is a solid fever line when it is above the zero line but becomes a hole when the cash runs out and the numbers go into deficits, swallowing up the poor people who may no longer receive their payments. The chart is drawn in perspective and then tilted to give a disoriented and destabilized feeling to the whole image.

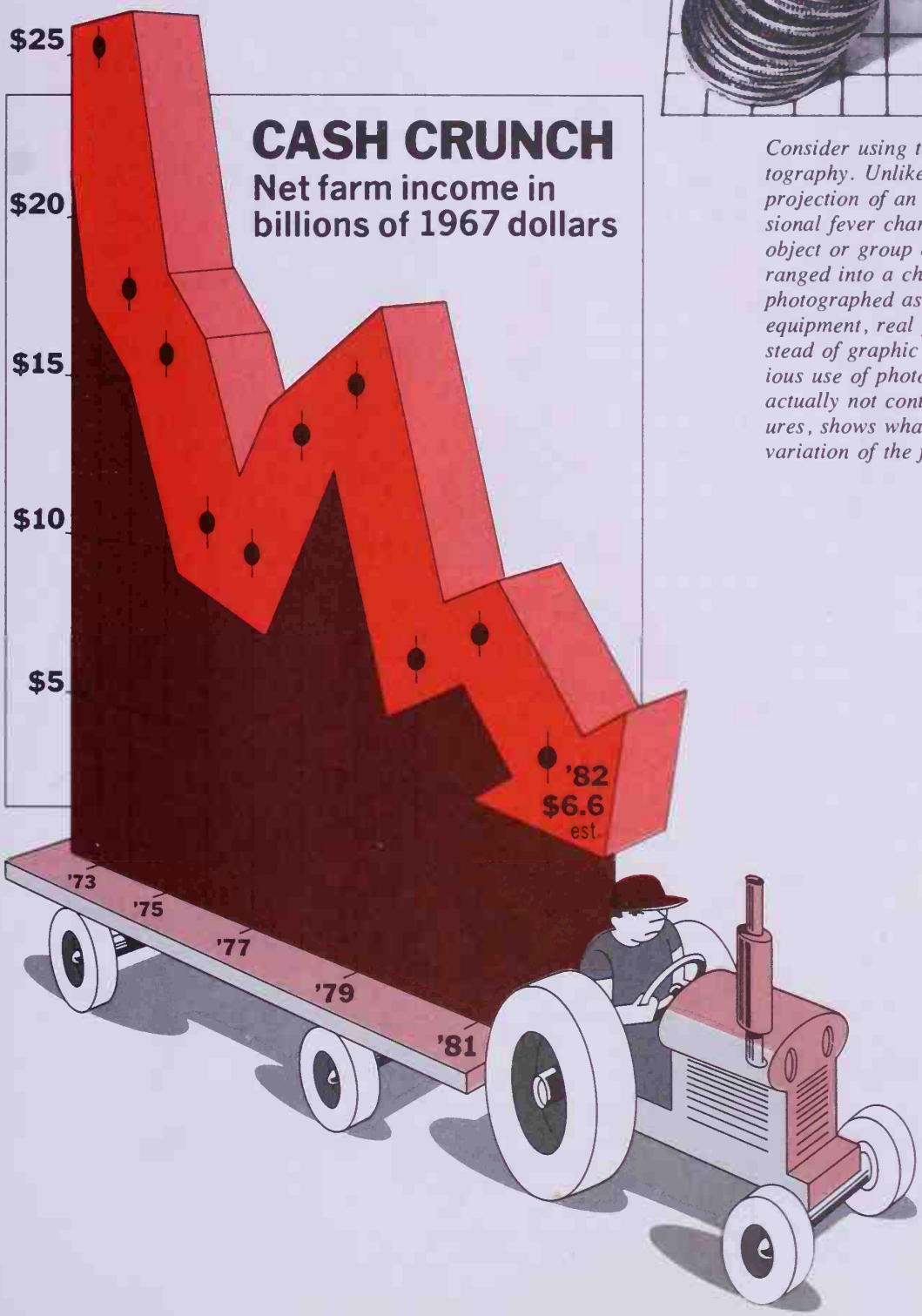


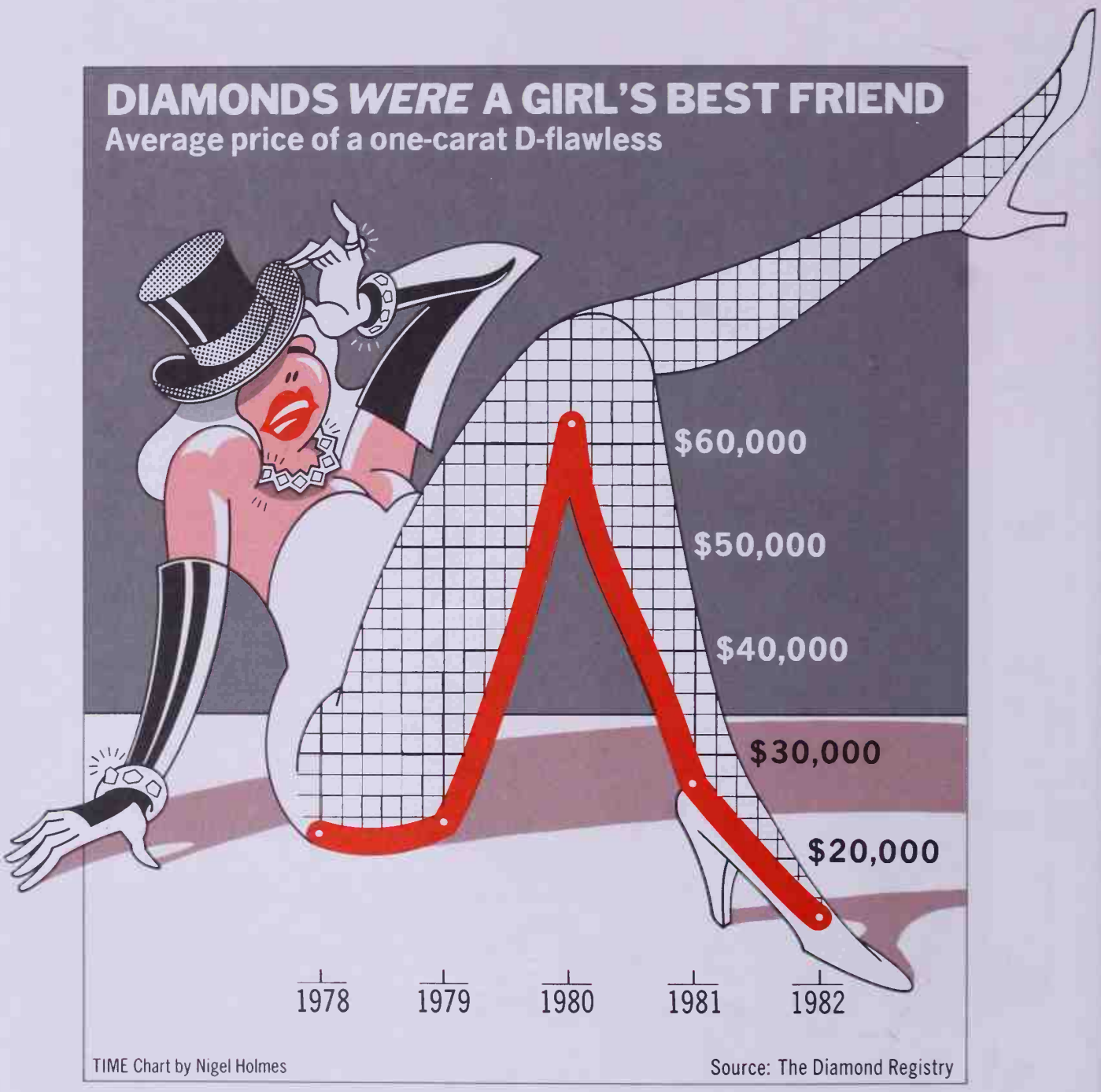


Many times it's appropriate to use a photographic background. Here a simple fever line with grid lines and labels is dropped out in white from a photograph of a North Sea oil drilling platform. This gives a very fast visual impression of the subject.

Three-dimensional line forms the top of the load on the tractor trailer and swoops down dangerously towards the poor farmer. Here the plot points are marked, but the overall trend down is outlined in a wider stroke.

Consider using three-dimensional photography. Unlike the three-dimensional projection of an otherwise two-dimensional fever chart discussed earlier, an object or group of objects can be arranged into a chart and then photographed as a whole. With the right equipment, real people can be used instead of graphic symbols. This ingenious use of photography, though actually not containing any distinct figures, shows what can be done with this variation of the fever chart.

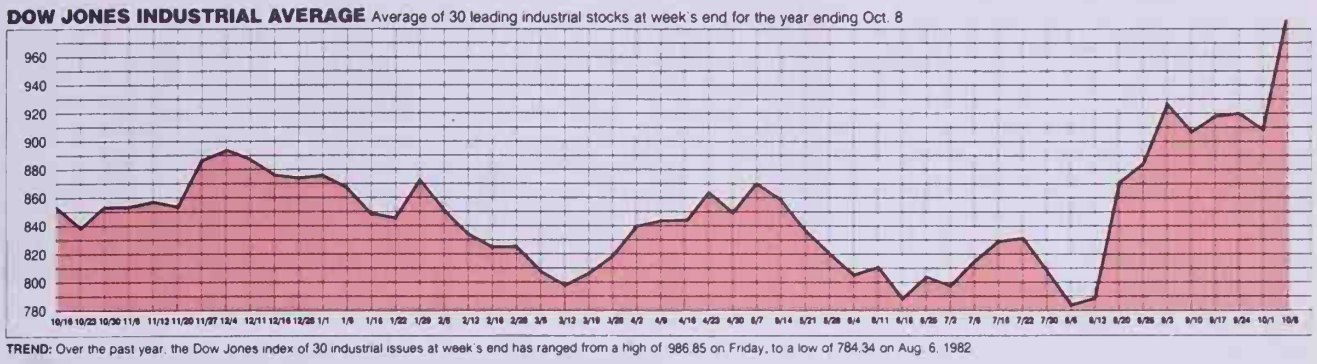




You can use an illustration where the actual shape of the plotted line can, without being forced, become a part of a drawing itself. More obvious cases might be mountain ranges and roller coasters, which in themselves can move up and down easily and thereby visually describe an idea while at the same time present the figures.

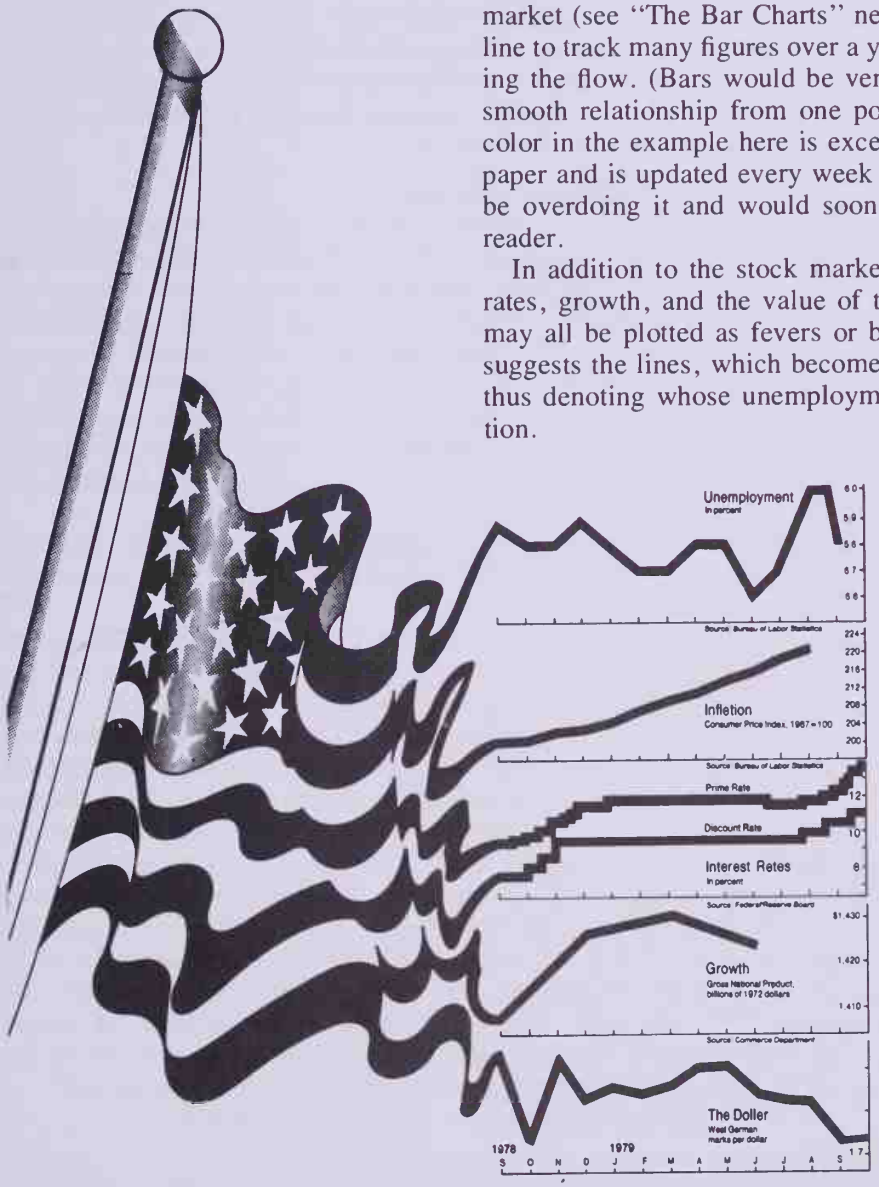
4. What Are Appropriate Uses?

The successful fever chart is one that shows clearly the relationship of the point immediately before it and the one immediately following it so that the reader can understand the flow of the figures. The line that results from connecting the various points can then be shown by itself or in combination to compare two or more sets of statistics.



Time Series. Although not always shown like this chart of the stock market (see "The Bar Charts" next in this chapter) the use of a fever line to track many figures over a year's span is very effective for showing the flow. (Bars would be very cramped together and not show a smooth relationship from one point to the next.) The simple use of color in the example here is excellent, and since it appears in a daily paper and is updated every week any additional embellishment would be overdoing it and would soon be annoying and distracting to the reader.

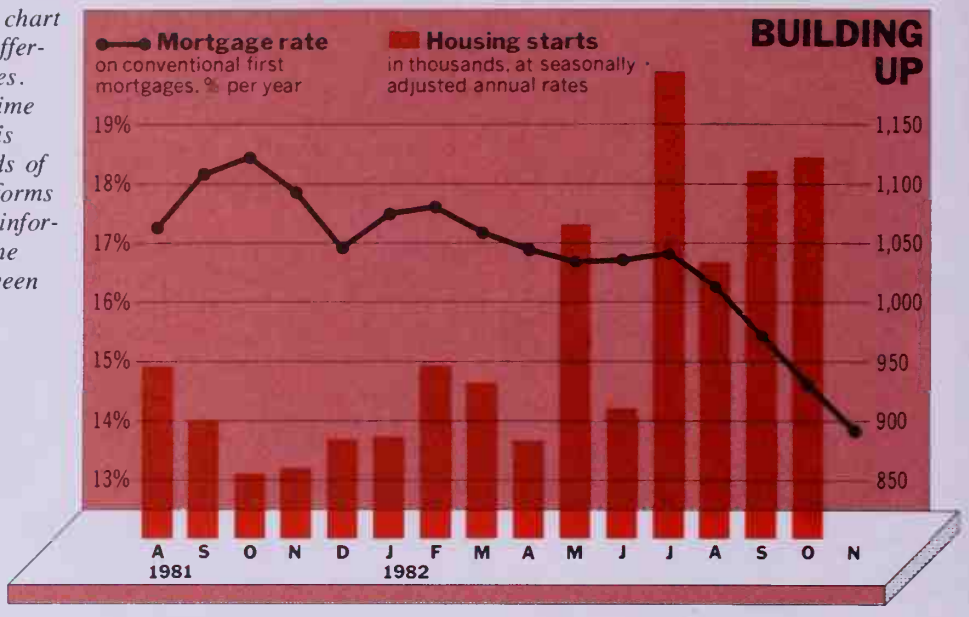
In addition to the stock market, unemployment, inflation, interest rates, growth, and the value of the dollar (against another currency) may all be plotted as fevers or bars, but the overall illustration here suggests the lines, which become part of the disintegrating U.S. flag, thus denoting whose unemployment, inflation, and so on is in question.



(Above) The single line fever chart of the year's Dow Jones figures is a good example of appropriateness of form. The flow of the numbers can be quickly understood from this uncluttered two-color daily newspaper chart.

(Left) Also from a newspaper, this time in black and white, a group of fever charts is held together by the overall image of the U.S. flag. Each of the six subjects plotted here is best served by the form of the fever chart, and the minimal grid allows both time (the same for all subjects) and quantity (different in each case) to be read easily with the minimun of graphic fuss, while at the same time allowing the lines to remain part of the flag.

A combination fever chart and bar chart is used here to link together two different subjects with two different scales. The factor common to both is the time period, but the fact that one scale is percentages and the other thousands of units demands that different chart forms be used to clearly differentiate the information and play one sort against the other, while retaining the link between them.



Combination of Information. Where one sort of information is to be played against another in a related field, but counted in a different manner, a fever line can be used effectively. Here a mortgage rate is shown in relation to the rate of building new houses ("housing starts"). The correlation between high mortgage rates and low building activity and vice versa can be clearly seen.

5. What Are Inappropriate Uses?

If there is too much information to be dealt with, or if the scale jumps from a tiny amount to a huge one, or if there is very little variation in the quantities, then the fever chart is not the form to use. Sometimes a great deal of plotting will be completed before it becomes clear that the lines are all going to cross over one another, thus possibly obscuring the information. At the beginning, the chartmaker will have to go through this exercise, but with experience and a careful preliminary reading of the data, it will be possible to save time by recognizing that a different form, for instance, a bar chart or a table, would better serve the information.

The simple rule is ease of reading. If you cannot be objective enough about whether the information is decipherable in your chart, ask a colleague whether or not it is.

Since the appropriateness of the fever chart has already been established for depicting a time sequence set of statistics, it follows that this form should not be used where no time period is involved. By joining one plotted point to its neighbor, there is an automatic implication that the second point has actually followed the first, as one event follows another. You will see, in the case of bar charts, that a number of different commodities can be plotted for the same time period. It would be nonsense to join all the plot points up as though they were connected.

If there is too small a variation in the quantities—say, the same number with different decimal point variations—then a table of the figures is probably a better choice. Some kinds of information need to be stated to two or three decimal places. Where this is the case and each figure has to be read, it is certainly better to print the figures themselves as a table, rather than plotting them on what would necessarily have to be an extremely complicated and finely ruled grid.

For examples of inappropriate charts, see Chapter 6.

6. What Are the Main Requirements?

In its most basic form, the fever is an easy chart to produce. An artist

can draw a passable chart in twenty minutes simply by drawing a grid, or using tracing paper over already printed graph paper, plotting the points from the two coordinates, and joining them up to form the fever line. However, it is important to know who is going to read your chart, for this will determine the final degree of finish: whether or not you write in the labels and numbers by hand, by stencil lettering, by using a burnish-on type, or by having the type set by machine.

Materials. Graph paper, which is available in different colors and with different increments per inch, should be kept in stock at all times. It will save you hours of boring work ruling grids. Tracing paper is the natural companion to graph paper. It allows the artist the chance to see the whole grid while plotting, but only end up with the most important lines actually traced through. This simplifies the chart by eliminating unnecessary grid lines—and saves graph paper too!

Some tracing pads are supplied with a sheet of graph paper bound in. This is often printed on heavier weight paper than normal and may be divided into eighths of an inch on one side and tenths on the other. This is very useful, but does not eliminate the necessity of having your own separate supply of paper. Where plotting is very detailed, it should be done directly onto a new piece of graph paper, so as to stop the chance that your tracing paper might slip, be moved inadvertently, or, by its very nature, slightly obscure the grid underneath.

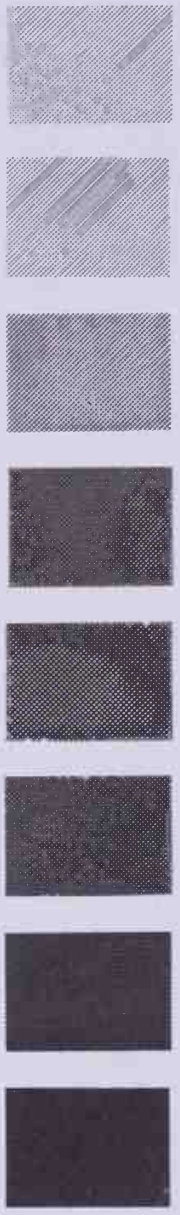
Colored and lead pencils always kept sharp will be needed for plotting. Use 2H or harder so that really fine, clear lines are drawn—even though it may be your intention later to draw a thicker fever line. By plotting properly in the first place, you will have an accurate base on which you may later choose to draw a more generalized curve.

You will also need a ruler with measurements in picas and inches, as well as 45-degree and 60-degree triangles, T-square, eraser, compass, Scotch tape, and register marks. These basic materials will see you through the initial stages of all chartmaking. For finished art you will also need a set of technical pens (with a compass attachment) in as large a range of sizes as you can afford. Buy the "jewel point" (or similar) for the thinnest sizes. The lines drawn by cheaper ones will thicken with use, so that it will become impossible to match line widths if you go back to the job later for corrections or additions. Make a note on your final tracing of the pen you have used for drawing each of the different kinds of line employed in the final artwork.

Trial and error will teach you which ink to buy for your pens. A pen that does not work because of clogged ink is infuriating, but whether or not they do clog depends on how often you use them, the weather—or atmospheric conditions—and on their own good or ill nature! Few of the "cleaners" on the market are as good as old-fashioned water and a little patience. Remember that after flushing a pen through with water, the line drawn will be paler to begin with, as it is virtually impossible to shake out all the water and thus the black ink is diluted for a short while. Scribble with the pen until it produces a jet-black line.

The material most generally used for finished art is Mylar or frosted prepared acetate. This can be bought in different weights and sizes, and again it is a matter of personal choice. Some of the makes are more transparent than others, but they can all be fairly safely relied upon not to stretch or shrink, unless subjected to extremes of temperature. Do not be tempted to dry a large area of black ink under an adjustable lamp pulled down to within an inch of it. It will dry it, but it will also curl the material so that it does not lie flat and is therefore hard to register with other overlays.

Technique. The descriptions that follow, together with those above on materials, apply to all forms of chartmaking and will only appear here.



Tones, available in a large range of dot sizes (screens), can be applied directly to line artwork by cutting areas from sheets of adhesive-backed film. The 55-line screen—that is, 55 dots to the inch—is a fairly coarse screen, for use in a newspaper. The screen size used for tones in this book is a 133-line screen.

Drawing. Drawing, in this context, refers to the way the idea behind the numbers becomes visible on the page. The fever line is plotted and drawn roughly by hand or very accurately with a ruler in pencil so that mistakes can be rectified and changes incorporated. It is important that everything about the chart be worked out at this early and easily modifiable stage, so that at the next stage, drafting, the work can proceed without hesitation or change.

Drafting. Drafting should be the merely mechanical procedure of turning the drawing into a printable form—a method of making pencil lines, with all their attendant erasures, notations, and wrong beginnings, into a neat, even, solid line that is thoroughly intentional. Good drafting is essential to the process of completing a good chart, for it is that part of the job which will eventually end up in the hands of the printer and which therefore most nearly represents the final printed image.

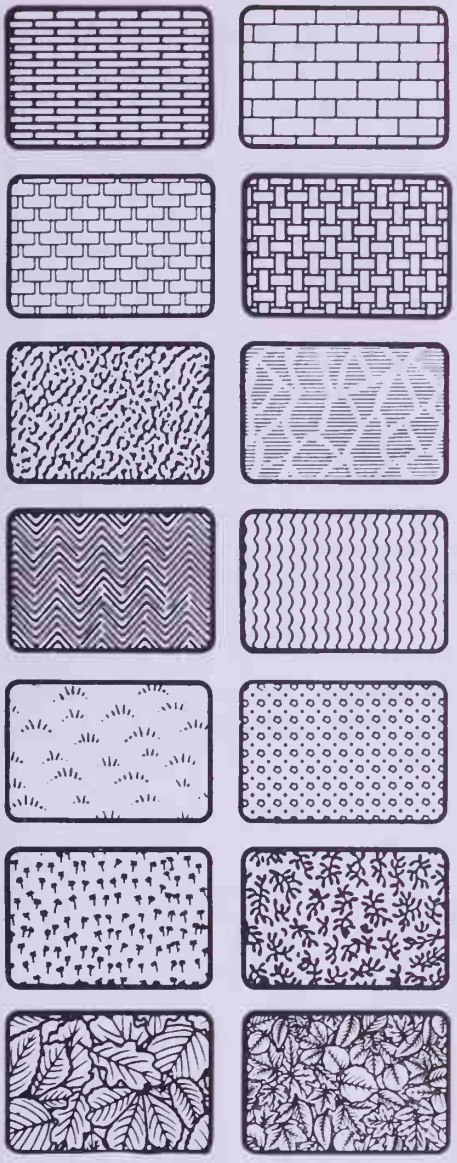
Typesetting. There are two cases where there may be no typesetting: first, if the chart is simply to be shown to a limited audience and not to be published; second, if there is so little type that it could easily be added with a pressure-sensitive, rub-down product. Most manufacturers have approximately the same range of typefaces, and they include those that are the most obvious choices for charts: Helvetica, News Gothic, Franklin Gothic—the straightforward sans serif faces. However, it is very difficult to keep the type really straight using these products for more than a few words, especially at the small sizes often used in charts, and so the best results can be obtained by using typesetting of one sort or another.

Some typewriters are equipped with perfectly acceptable faces, though limited in size, but the best results will always be obtained by having the type set on a professional typesetting machine. Since this is possibly the only part of the production of your artwork that you do not actually do yourself, plan ahead for the type so that it does not hold you up at the end of your job. It should be possible to work out the size of type needed at the same time as you plan the rest of the chart.

Whenever possible, be involved with the application of the type to the chart. In a freelance situation, art directors may suggest that they handle the type—you just do the charting. They are missing the point of the chart, which by its nature contains numbers and type that are part of the design. A chart is not, and should not be thought of as, an illustration, which can be manipulated later in an art department. If the numbers are not ready for you to apply to the chart, then you should not be starting the chart at all.

Tone. Tones of black and white are used to differentiate areas or types of information. Thus a background may be a light tone and the fever line dark to contrast with it, or vice versa. If more than one line is plotted, a different tone may be used for the second and subsequent lines or areas between them. Tone can be applied by cutting Amberlith overlays, which, duly notated, are translated into screens by the printer. Alternately, it may be applied directly to the artwork by cutting areas of it from sheets of pressure-sensitive film, which are manufactured in various screen sizes and applied as a line constituent of your artwork (since the printer does nothing to it but treats the entire artwork as a piece of line).

Remember to use the correct screen size for the type of reproduction and for the type of paper on which the chart will be printed [rule of thumb: no more than 55 lines (dots) to the inch for newspaper or newsprint reproduction]. If you are working larger than the final printed size, allowances must be made for the reduction involved. By applying



(Above) The different patterns available in adhesive-backed film can literally illustrate such things as bricks, grass, and leaves, or be used to great effect as abstract tonal areas in a drawing.

your own tone as line, you are also able to control the look of the image in an interesting way. If you deliberately choose to use a screen of larger dot size than would usually be used in a straightforward toned conversion, a whole set of different visual effects are possible. You can also experiment with different patterns as areas of tone instead of simple dots.

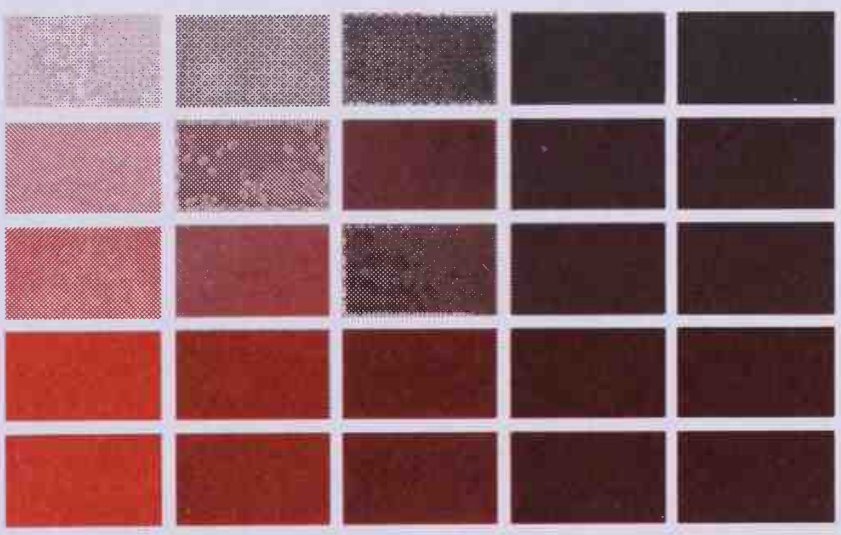
Color. When the budget allows, color can be used instead of, or in conjunction with, tones of black and white, as described above. Sometimes only one color is available. If you have a say in the matter, red is generally the best choice, unless the subject itself suggests another color—for example, blue for a chart about water shortage or yellow for gold prices. Except in such obvious cases, red as a second color is the most versatile in terms of tonal value and simple graphic clarity.

The accompanying illustration shows the wide variety of colors that can be made from mixing just red and black of different tonal strengths.

Where tone is not involved, red consistently is the brightest and clearest color for adding emphasis to a chart. Parts of this book are produced in black and white, parts in full color, and parts in two color. There was never any doubt in my mind about the choice of color for the two-color sections. Red simply does the best job on all counts: versatility of tonal variation, graphic clarity, most straightforward signaling of a point to be emphasized, and greatest contrast with black.

Where full- or four-color is available for an artist to use, care should be taken that it is not used too decoratively, simply to dress up the information. Impact may be achieved by limiting yourself fairly strictly. In print the job will probably be in full-color only because color pictures are being used elsewhere on the page or magazine, not necessarily because it is deemed essential that the chart be in full color. Do take the opportunity when it arises, but use the color carefully.

As with tone, color can be indicated on your artwork with overlays. Although this is technically the best method—certainly the method that will produce the finest reproduction of your work—be prepared to supply a finished colored rendering of your chart along with the final art. Few clients will be able to understand, let alone visualize, from the appearance of your final art with its overlays instead of the actual colors the ultimate look of the chart when it is printed. Do not give a client any chance to reject your hard work because they do not understand the technicalities of print preparation. There is no reason why they should understand it. The added work on your part of preparing a tissue overlay to indicate what the colors will look like will pay off in the end.



(Right) A printed combination of just two colors—red and black—produces a huge range of tonal values and colors. Each block in the left-hand column is 10% black, overprinted with increasing tonal intensities of red. Thus, from the top, the red blocks are 10%, 30%, 50%, 70%, and finally 100% in the bottom left-hand corner. The second column from the left is 30% black, the third 50% black, the fourth 70% black, and the final column, on the right, is 100% black. The same sequence of red tones as was used in the right-hand column is overprinted in the other columns.

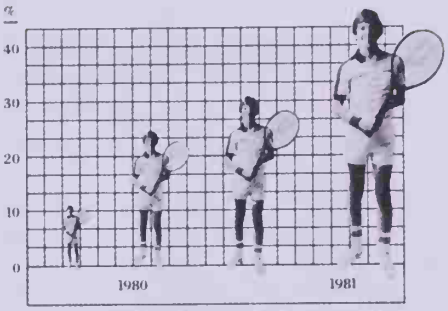
THE BAR CHART

This form of chart lends itself to many variations and is in some cases interchangeable with the fever chart, but while that is most concerned with the representation of a time series, the bar is also suitable for the depiction of non–time-related subjects.

Let's examine the bar chart in relation to the following six questions.

1. What Is the Definition of the Bar Chart?

The bar chart is a series of bars or columns representing amounts of data. The height or length of the bar equals the amount being shown. Some definitions of a bar chart call upright bars "columns" and horizontal bars "bars."



Source: Annual USTA Yearbook for 18 under boys' rankings.

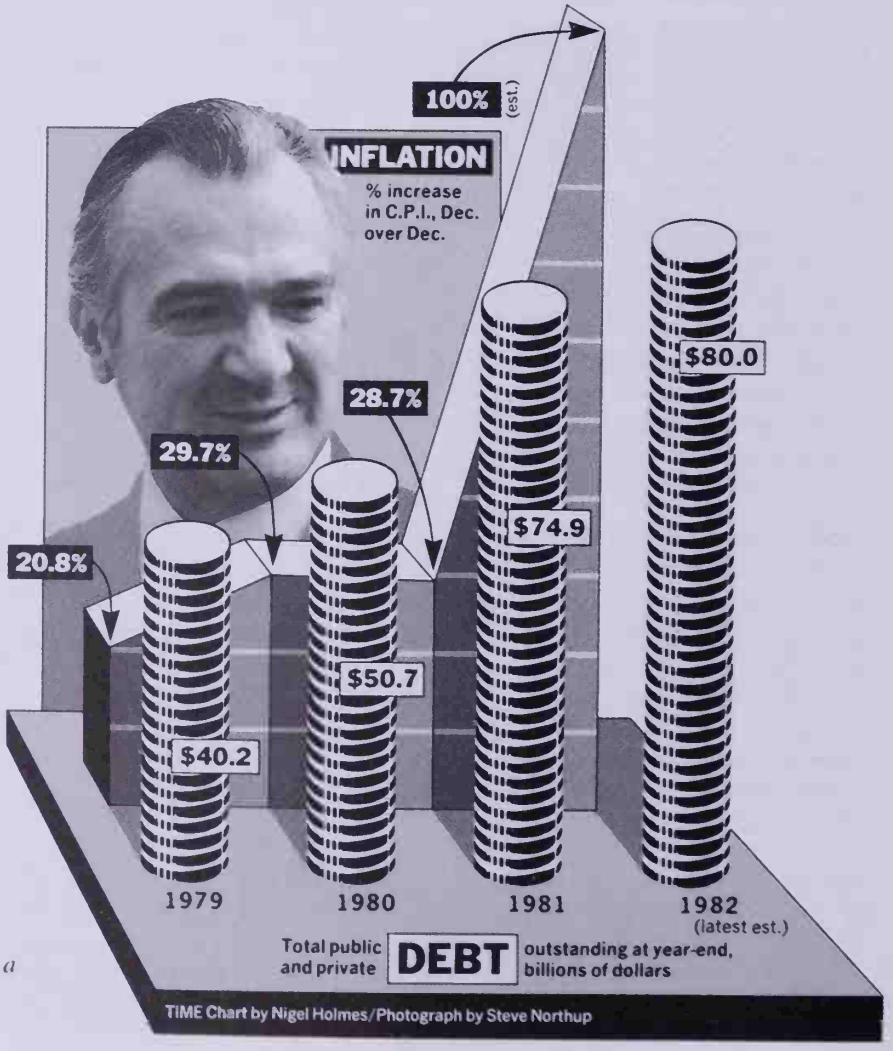
Photographic bar charts use real objects or people instead of drawn ones to depict the statistics.

2. What Are Its Main Elements?

Elements grouped together into bars or piles or columns are the primary ingredients in a bar chart. They may be laid out vertically or horizontally or at some angle in between. In order to understand the quantity of the commodity or subject being measured, it must be laid out according to a grid or scale, which is then an essential part of the finished chart. Color and labeling are other main elements, as in the case of fever charts.

3. What Variants Are There?

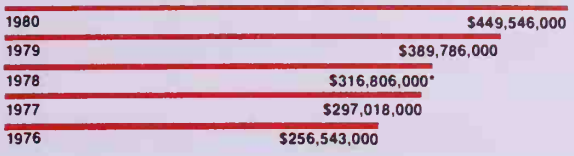
Like fever charts, bar charts come in many different forms—from simple upright lines, through the third dimension and illustration, to in-scale comparisons of actual objects.



Photographs may be combined with other graphic forms, as in this case of a three-dimensional bar chart and a three-dimensional fever line.

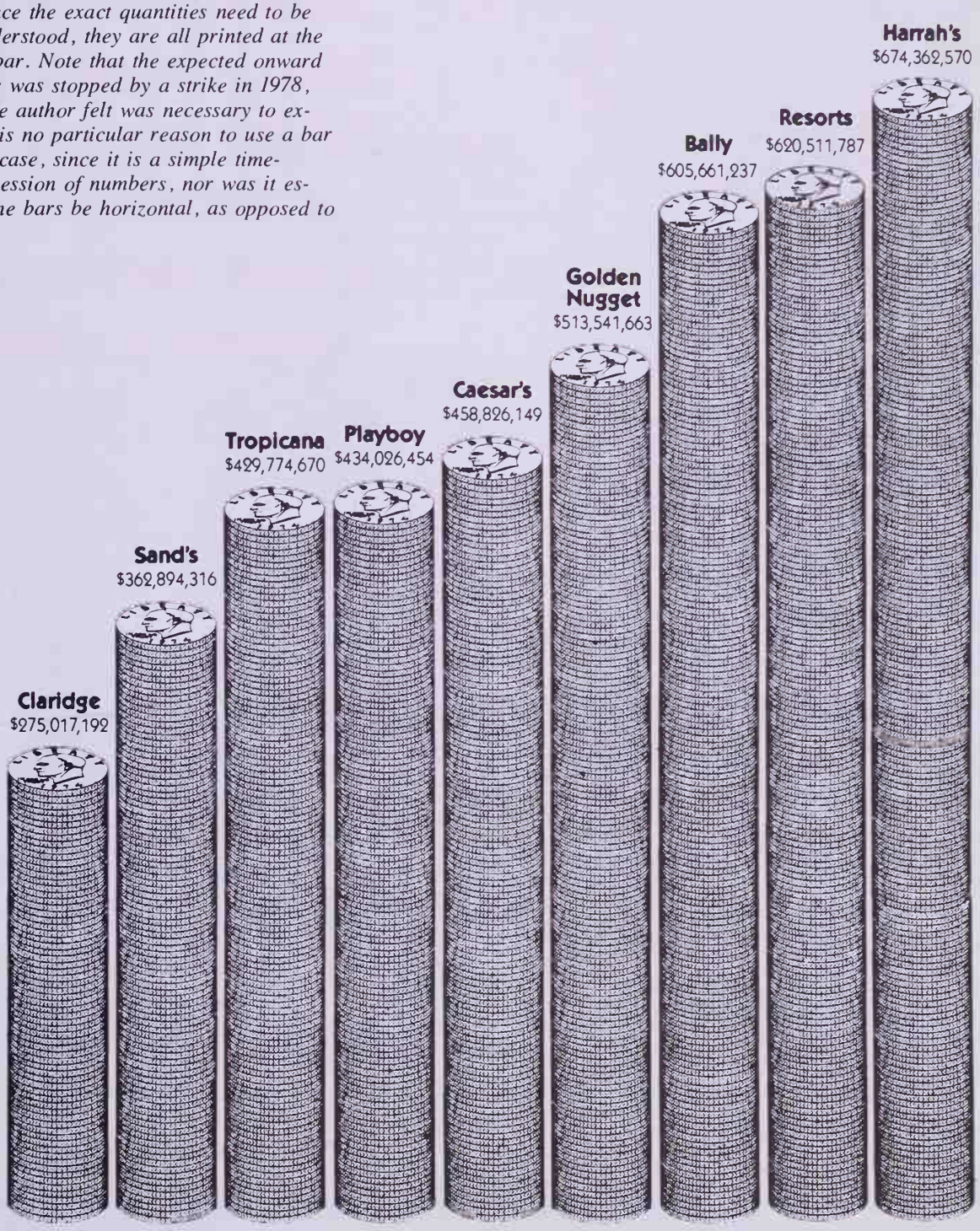
Total assets up 75% since 1976

*1978 results adversely affected by a strike at The New York Times

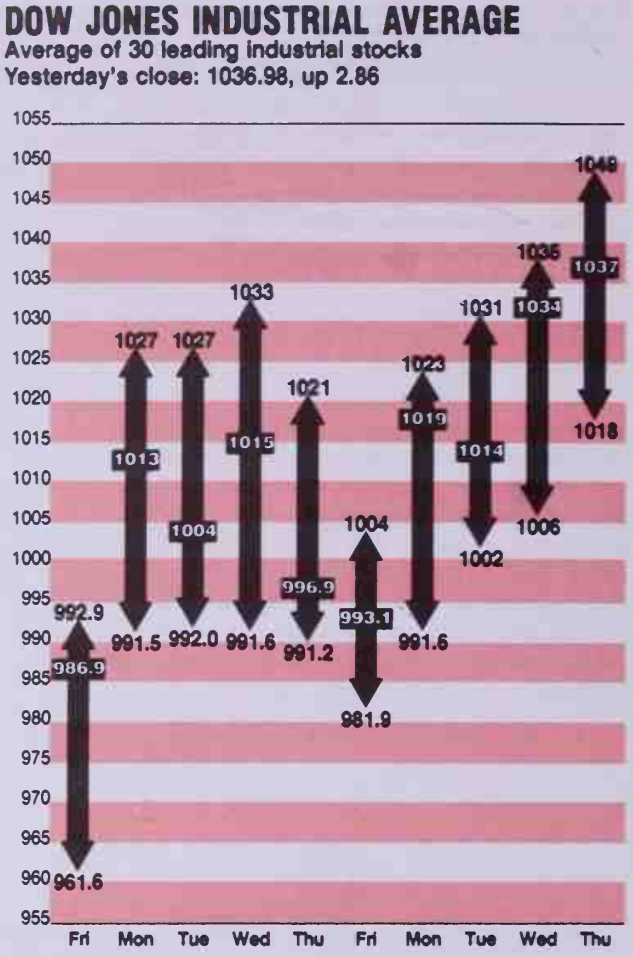


The simple bar chart is a flat, two-dimensional abstract drawing. In this illustration from an annual report, the most basic type of bar is used, and since the exact quantities need to be read and understood, they are all printed at the end of each bar. Note that the expected onward flow of assets was stopped by a strike in 1978, a fact that the author felt was necessary to explain. There is no particular reason to use a bar chart in this case, since it is a simple time-related progression of numbers, nor was it essential that the bars be horizontal, as opposed to vertical.

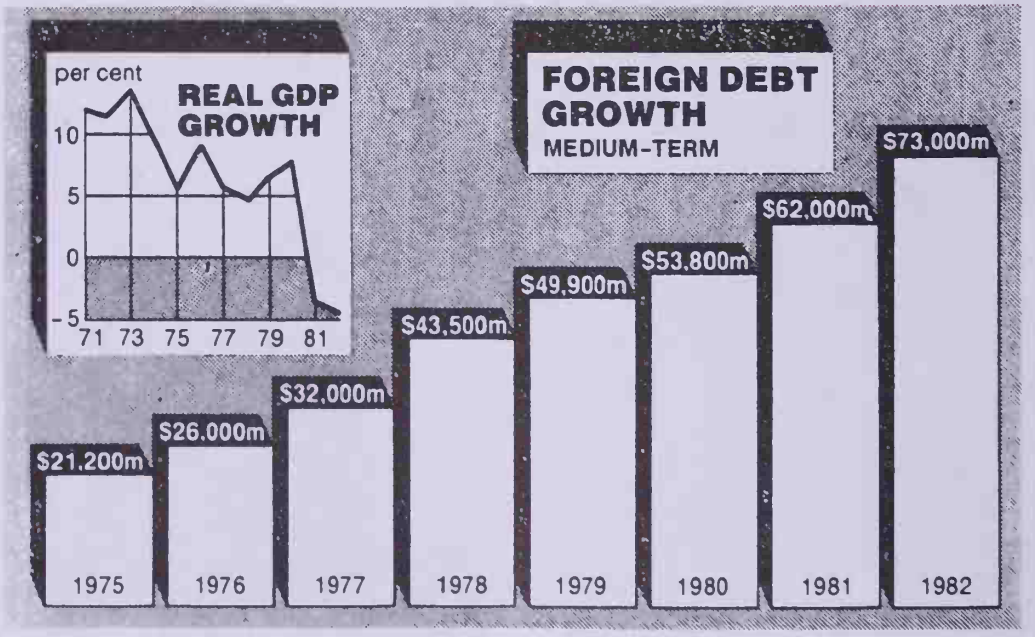
The bars themselves may be drawings of the commodity being measured in the chart—in this case money.



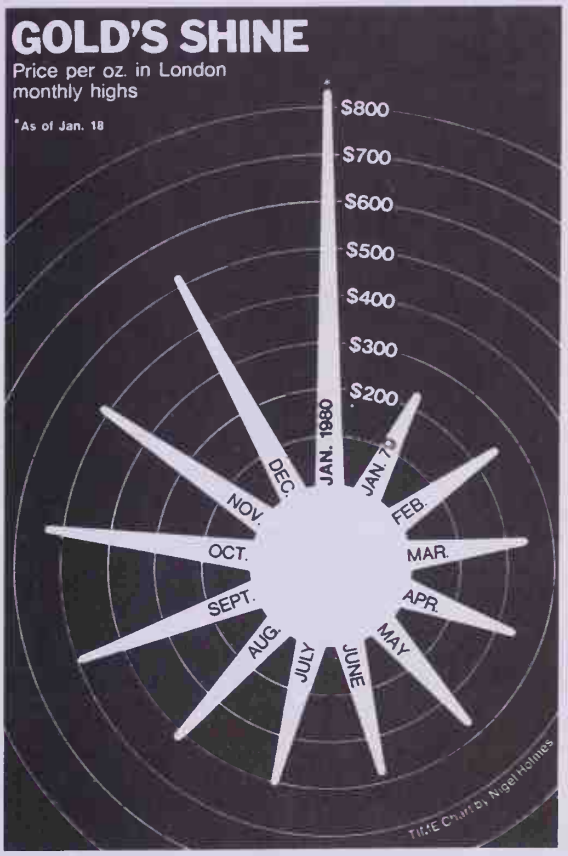
Double-ended bars are useful for work-in-progress flow charts and, as in this case, for plotting the three points in a stock market day: the high, the low, and the close.



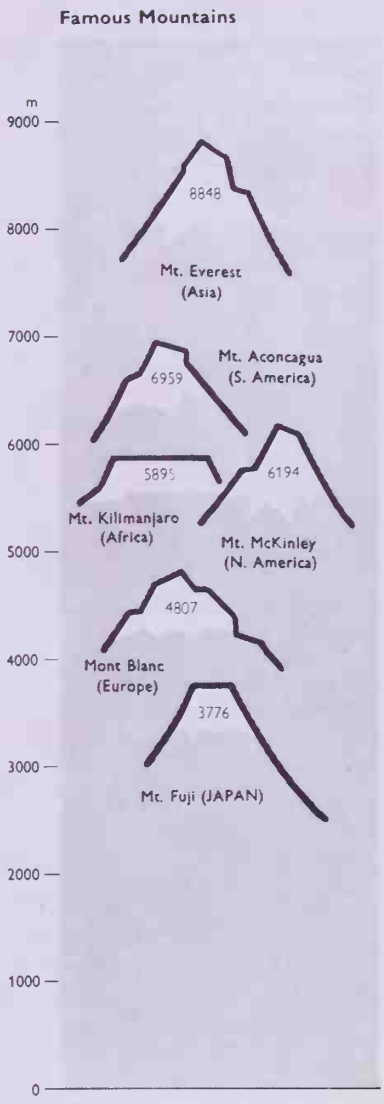
A simple, flat drawing may be projected into the third dimension while still remaining abstract. The artist has neatly used the black area at the top of each bar to contain the exact quantity of each bar, thus providing precision with a simple visual depiction of the quantity. The title box and secondary (fever) chart are treated with a similar black shadow to give a cohesive look to the whole.



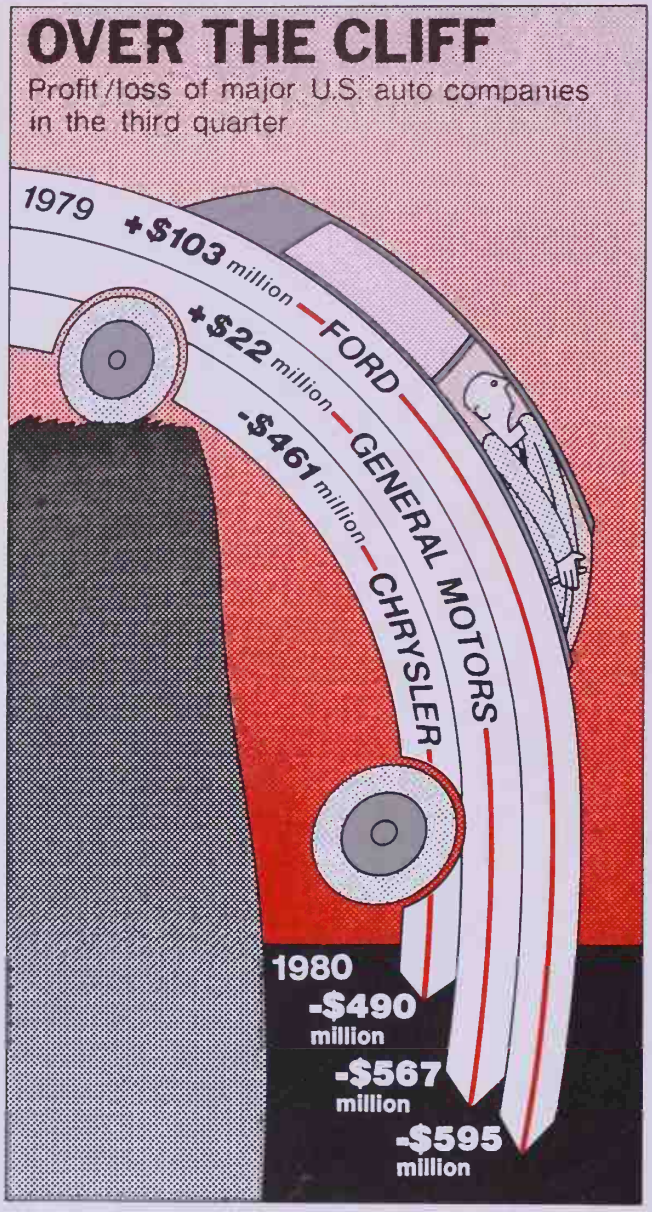
Bars may be composed of a number of individual elements, each one representing a certain amount of the substance being charted. This is a very useful and highly recommended form of chart. By keeping all the elements the same size, the common and misleading error of changing the size of one element—in this case one fish—to represent the different quantities is avoided. Somewhat of a drawback, however, is the problem of how to deal with fractions of the whole. Here the exact amount is printed so there is no confusion.



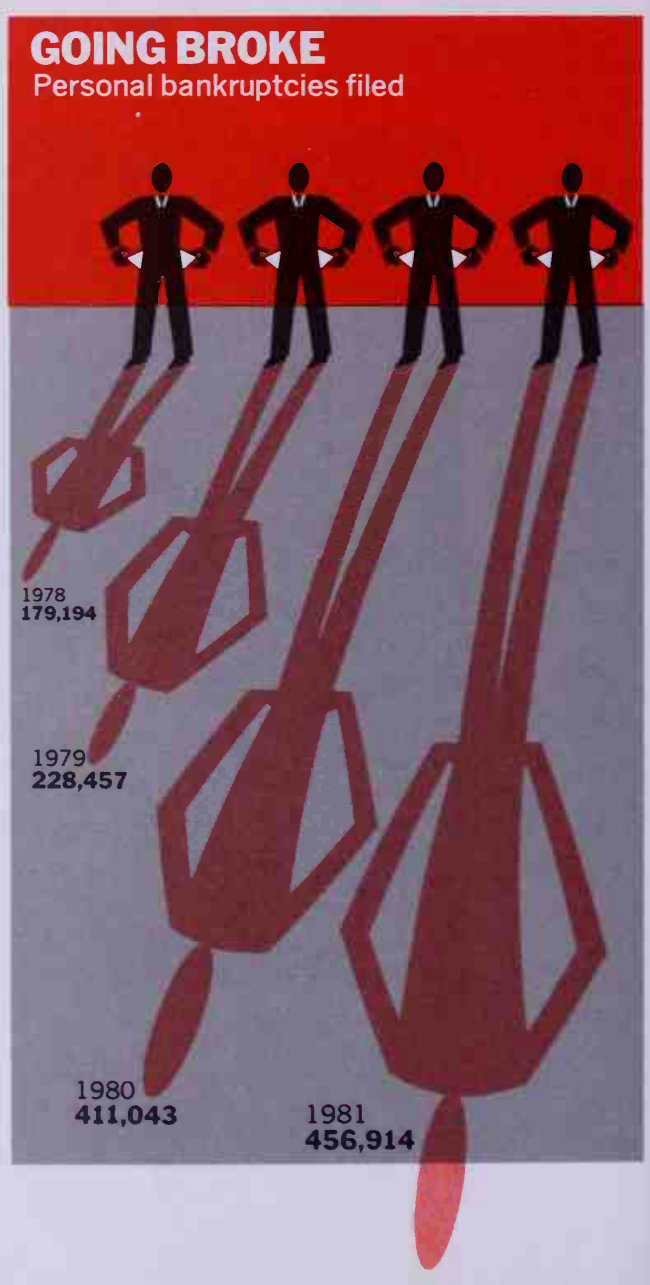
Circular bar charts, sometimes called "star graphs," are particularly useful for showing the first figure to be plotted immediately next to the last one. In this chart of gold prices, the beginning of one year is plotted next to the beginning of the following one.



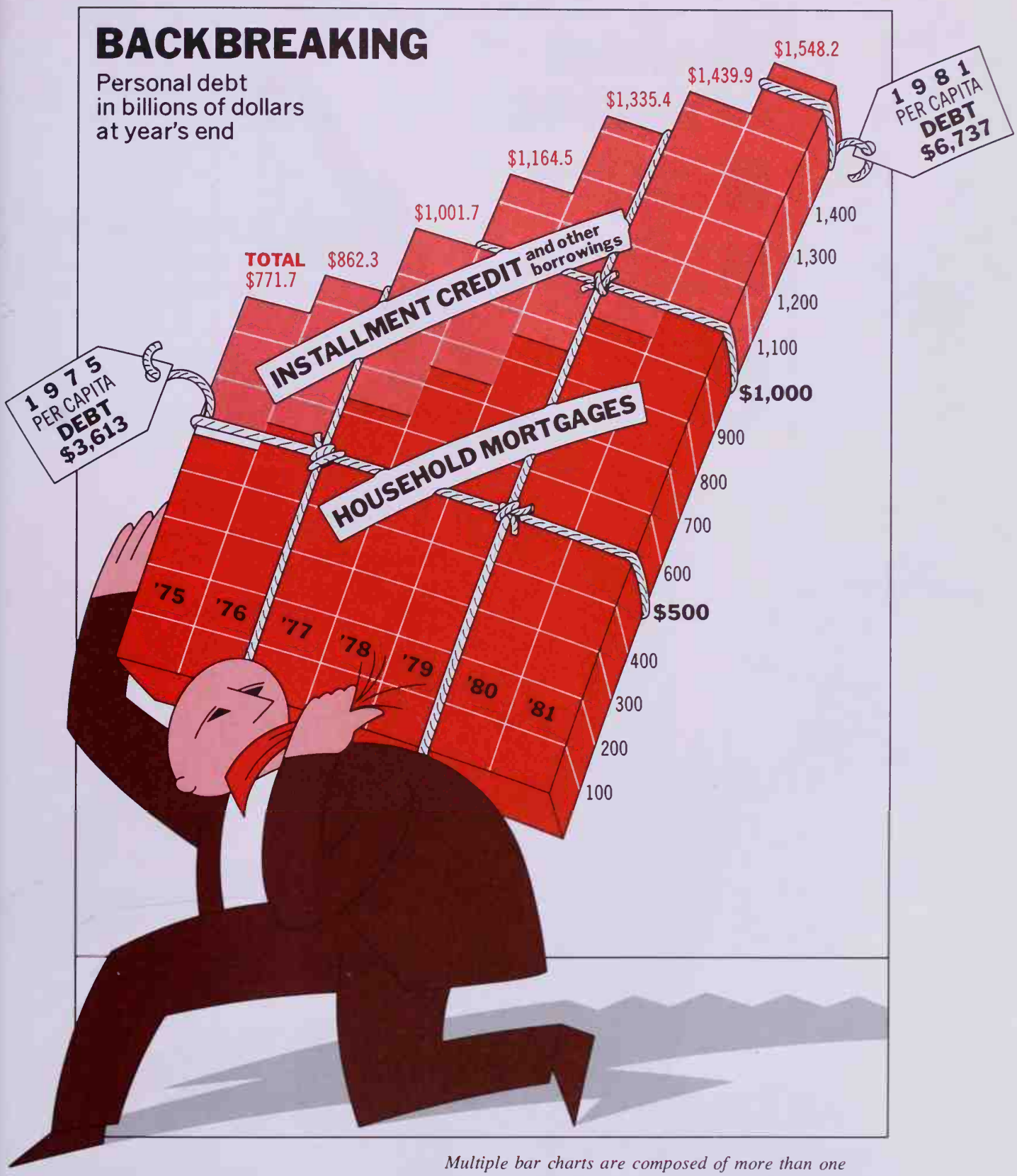
In-scale drawings of related objects can be called "pictorial" bar charts of a kind. They are visual comparisons after all. These simplified drawings of the highest mountains in the world could just have easily been drawn as simple bars—but how much more effective they are as the shapes of the mountains themselves.



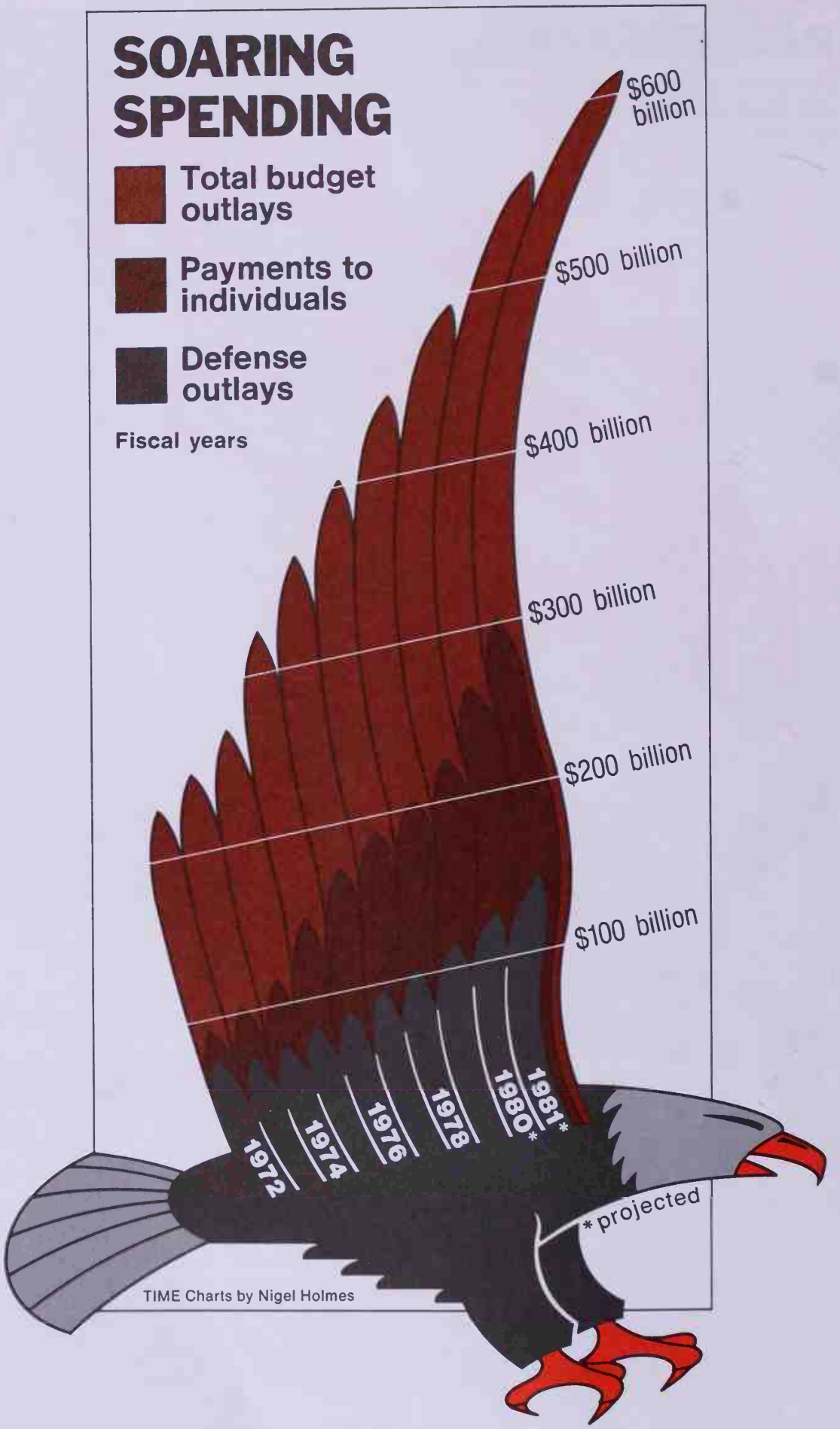
The bars may be bent into a shape that in some way describes or amplifies the data. Beware of the possibility of distortion. This example shows the exact amount in figures.

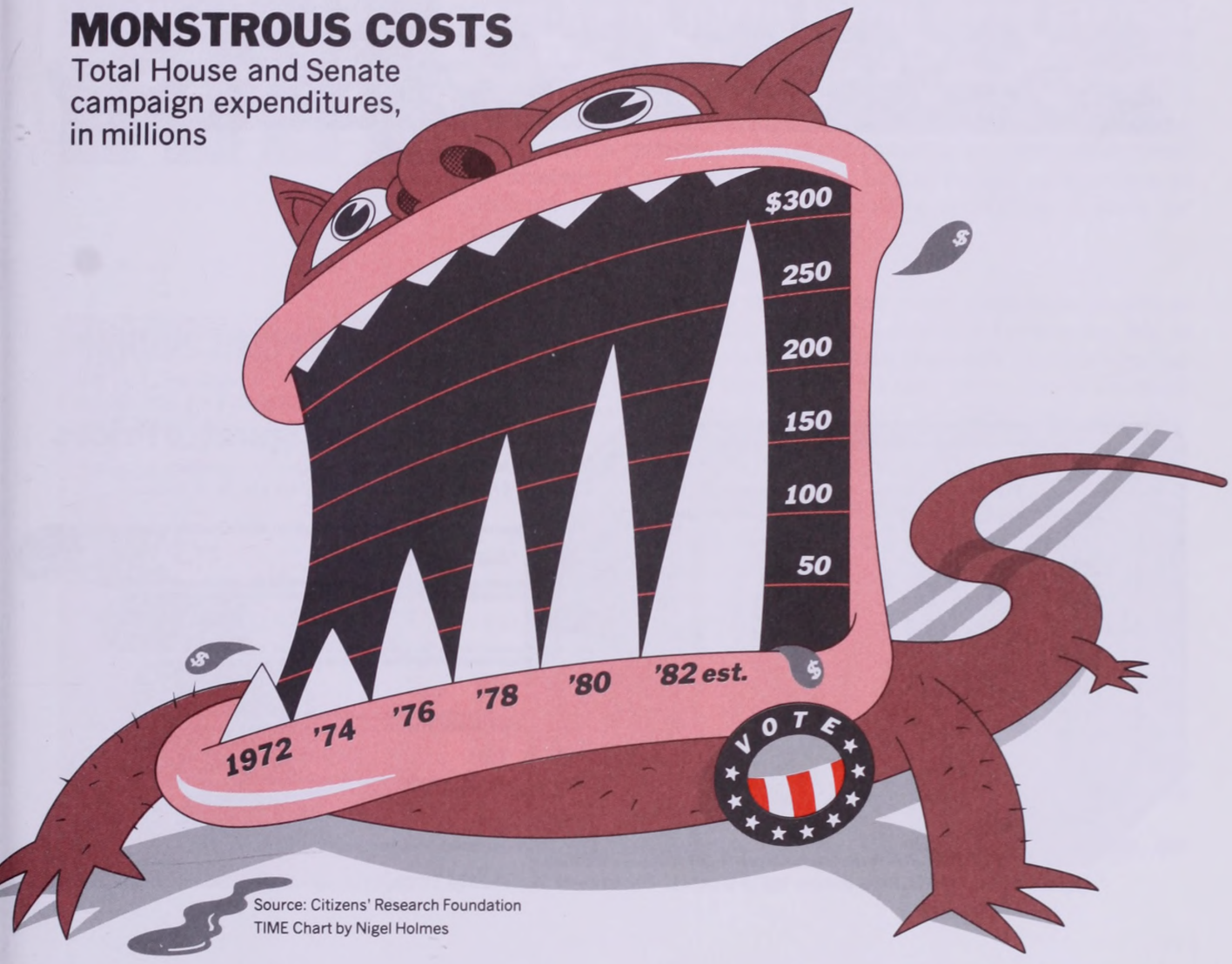


The bars may be projected down instead of up, especially when doing so is appropriate to the subject. In this instance, the idea of being deeper in debt or trouble is matched by the downward thrust of the bar/shadow.

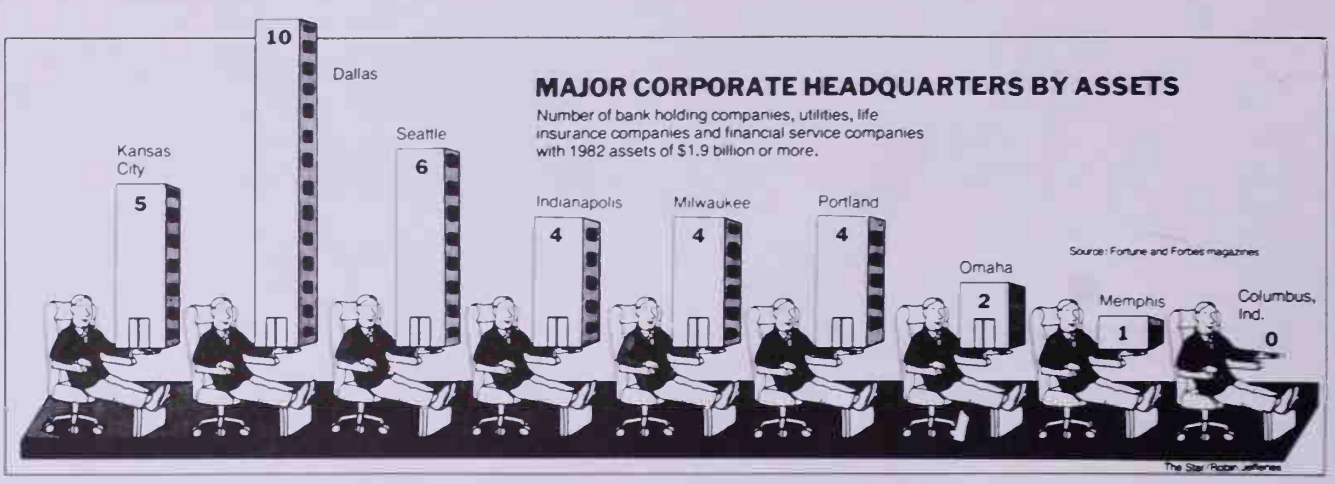


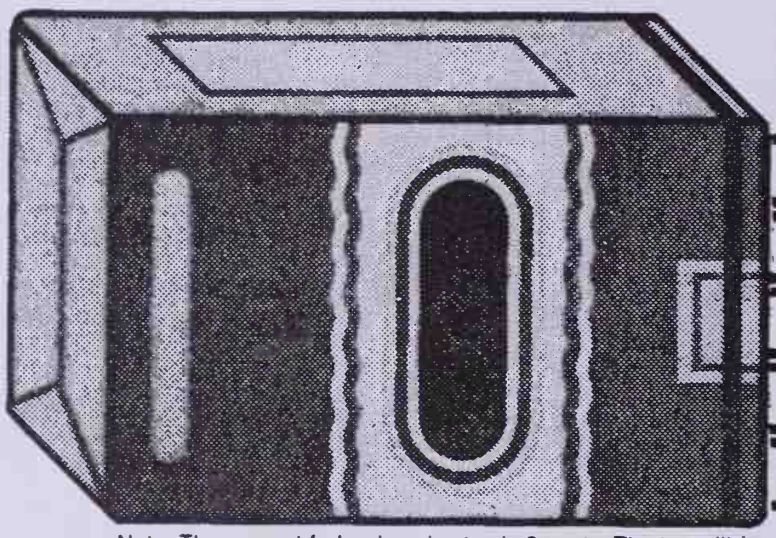
Multiple bar charts are composed of more than one ingredient. Two elements for the same time period are placed one on top of another. At the most only three ingredients should be used for each bar, as it becomes very difficult to read the quantities of any but the bottom one—that being the one which starts at zero—without a fair amount of mental arithmetic.


SOARING SPENDING
Total budget outlays
Payments to individuals
Defense outlays
Fiscal years
$600 billion
$500 billion
$400 billion
$300 billion
$200 billion
$100 billion
1972
1974
1976
1978
1980*
1981*
* projected
TIME Charts by Nigel Holmes



In certain cases the measured elements in a bar chart can be woven into a total picture so that the whole drawing is a chart. These two animal charts demonstrate this principle: No abstract elements are added to the eagle or the monster. They are not backgrounds or adjuncts to a chart: They are the charts.



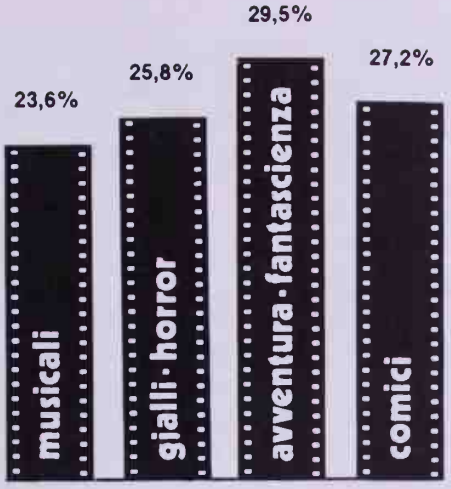


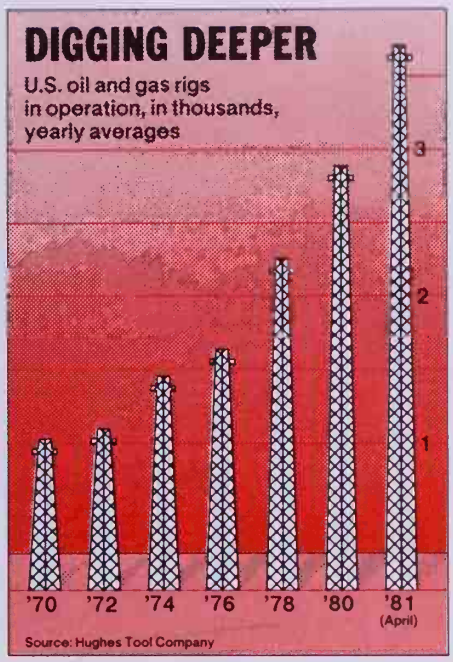
The Rise in Cigarette Prices

Average retail price per pack of cigarettes, in cents. Figures include federal, state and local taxes

'82 (Through Oct. 31)	81.9
'81	63.0
'80	60.0
'79	56.8
'78	54.3

Note: The current federal excise tax is 8 cents. The tax will increase to 16 cents in January. *Source: Tobacco Institute*





The illustrations of cigarettes, corporate headquarters, filmstrips, and oil wells show that almost anything which can be extended in one dimension can be used to depict itself in a chart.

4. What Are Appropriate Uses?

The bar chart is most useful when you need to show individual numbers in a series or when you want to plot different items at the same time.

Time series. While the fever line gives an impression of the flow of a series of numbers, the bar gives more individual prominence to each amount being plotted, since each amount has a complete bar to itself, rather than being joined to all the others in the series. Thus it is appropriate to use this form of chart where the priority is to comprehend individual numbers within a series. If an overview of Dow Jones statistics for a few months is required, use a fever line. If a detailed look at the last two weeks' daily closings is what's needed, use a bar chart.

Non-time series. A completely different function of the bar chart is the comparison of different commodities plotted at one given time. Thus, for example, if you are showing the cost of renting an apartment in different cities across America, it would be appropriate to use a bar chart (and nonsensical to use a fever).

5. What Are Inappropriate Uses?

In some cases, there may simply be too many numbers to be able to show them all individually. The bars would then become too thin to make sense in terms of space. If you must place bars too close together their point as individual bars is lost. In a case where there is too much data, print that as a table or suggest that it be edited down. Only then should a bar chart be attempted.

As has been noted before, if the flow rather than a look at individual numbers is the prime consideration, then the bar chart is inappropriate.

6. What Are the Main Requirements?

Although bar charts can be achieved quickly and effectively by simple freehand drawing, they always look better when they have been ruled out neatly and accurately. They therefore take longer and consequently cost more to produce in man-hours than the simpler fever lines. Moreover, since there may be information about more than one commodity in the chart, there will be more labels. Thus typesetting costs will be greater, and the type will demand more careful planning—for instance, how it's placed within the design and how it's specified to make sure that it is readable. In turn, where more type is involved, more time should be allowed for proofreading and fact checking.

For a review of the materials and techniques to choose from, see page 35.

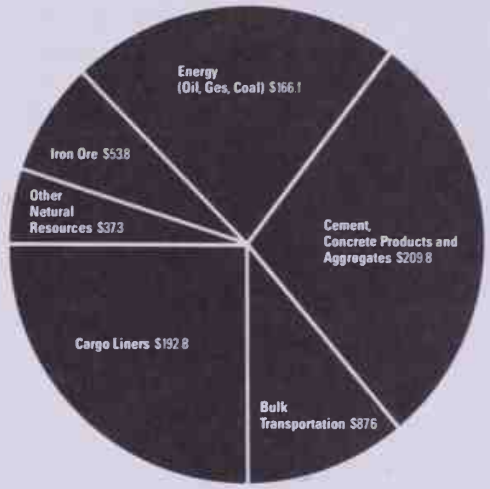
THE PIE CHART

If the names of the first two types of charts seem to be literal—the feverish fever chart, the blocklike bar chart—then the pie chart's obvious reflection of its source should come as no surprise. Slices of the pie, pieces of the cake, parts of the picture all describe the activities of this, the third type of graphic presentation.

Answering the six questions that follow will help you understand the characteristics particular to the pie chart.

1. What Is the Definition of a Pie Chart?

The pie chart, or divided circle, is a method of showing percentages of a whole. The complete circle, or whole pie, represents 100 percent. The "slices of the pie" are the divisions of that 100 percent, sized according to the magnitude of the percentage of each individual piece. For example, a 50 percent slice of the pie would be half of it.



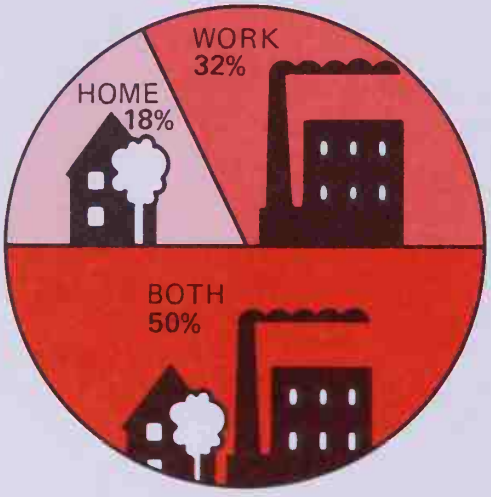
The simple two-dimensional figure shows lines radiating out from the central point to the circumference. The understated elegance of this breakdown of revenues is most effective.

2. What Are Its Main Elements?

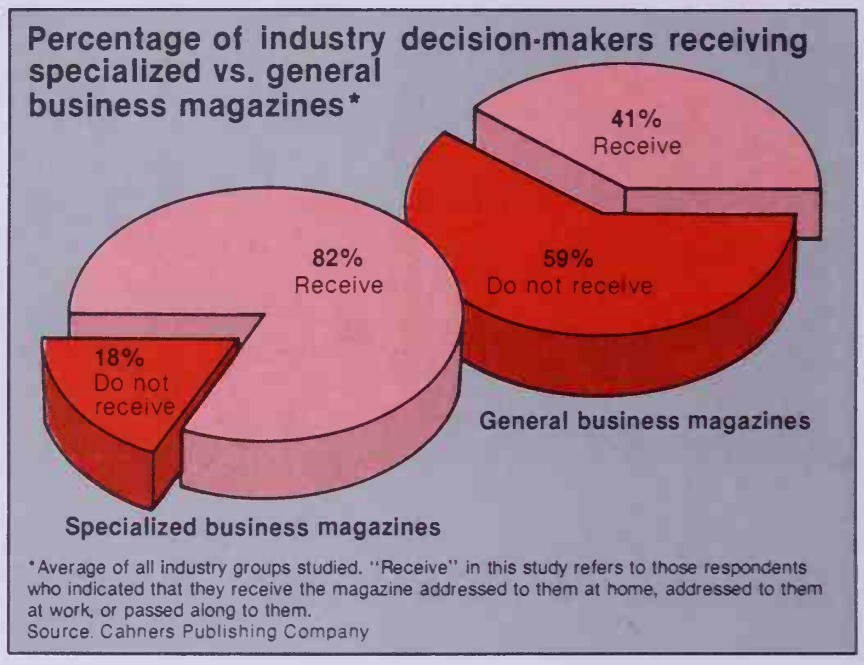
In the basic form, there are merely two elements: the circle and the typically triangular shapes representing the subdivisions, or percentages, of the whole. The labels and the placing of them accurately in relation to their relevant segments are the only other elements needed to construct a pie.

3. What Variants Are There?

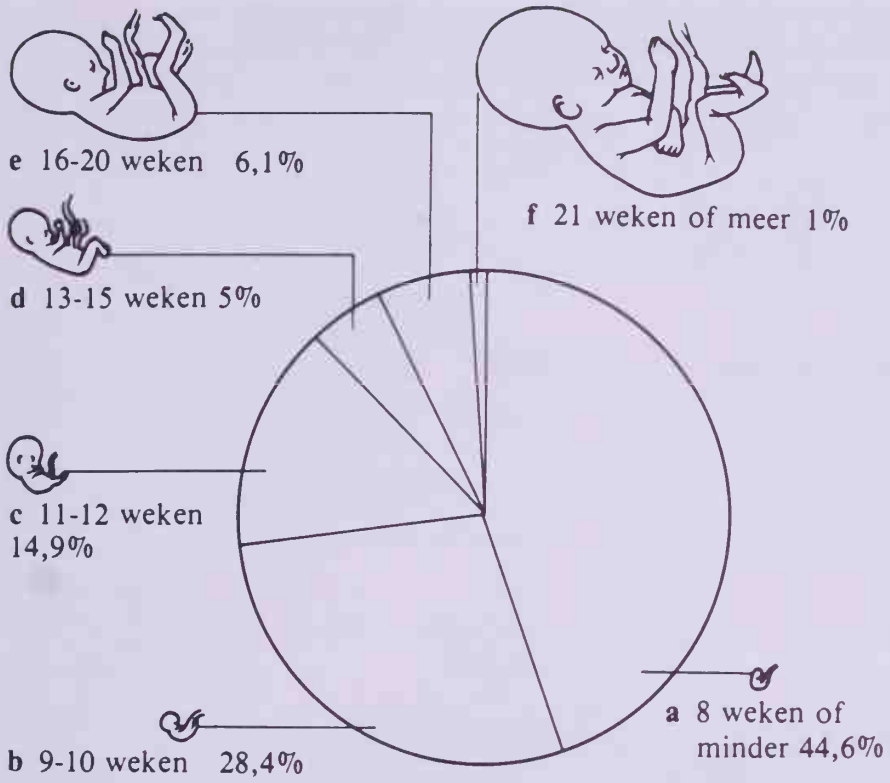
Pie charts are perhaps less flexible in their variations than fevers or bars, but nevertheless they can progress from the simple to the illustrated while still revealing their numbers efficiently.



As an example of an illustrated pie chart, the use of computers by home and industry is shown by symbolic drawings inside the segments.

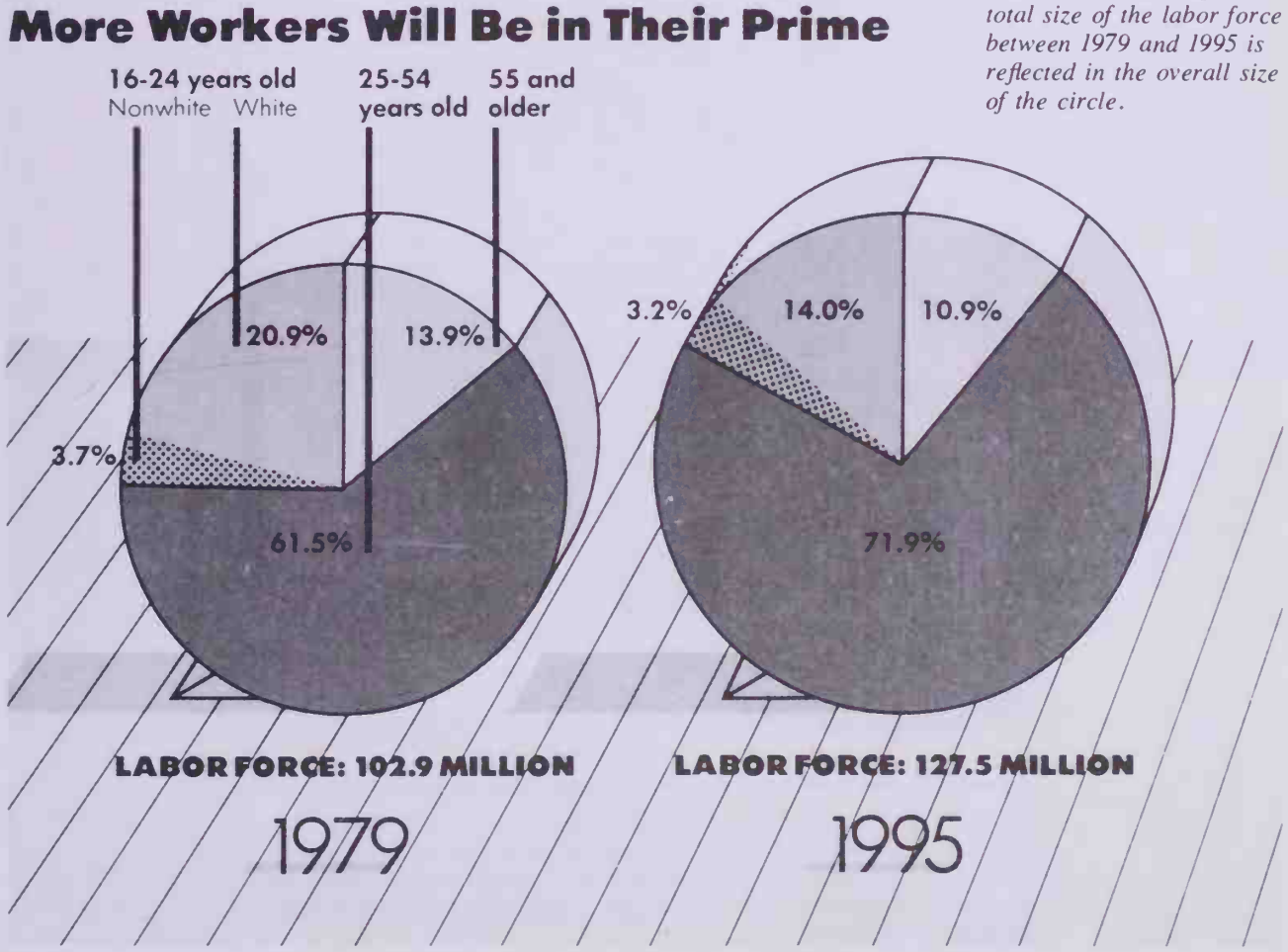


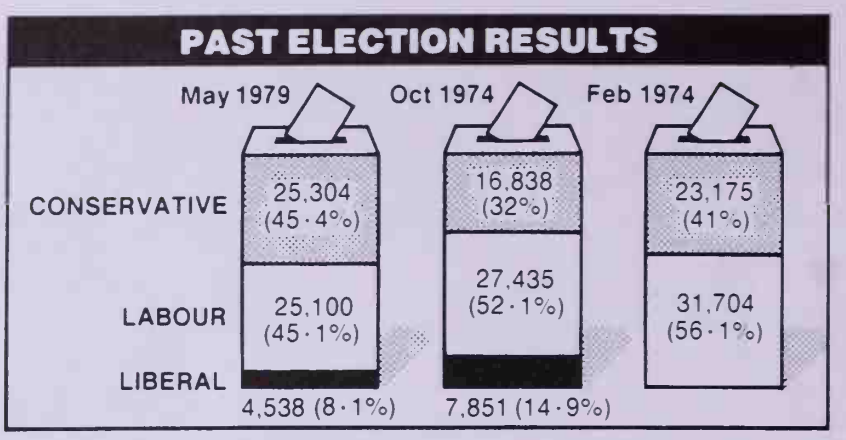
Using the third dimension allows the circle to be tilted back into an oval, giving the impression of it sitting on the page. Definition and emphasis can be put into the chart by separating the information and making almost a real "slice of the pie."



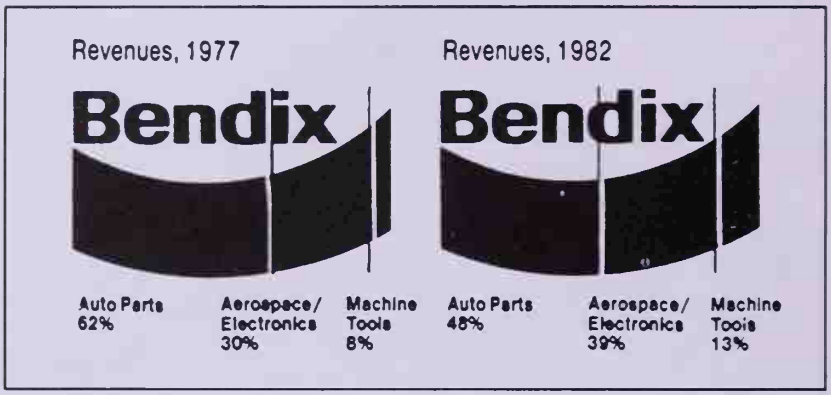
The simplest of pie charts can be made visually more enlightening by the addition of line drawings, in this case showing the growth of the fetus. Note that in this example all the labeling is contained outside the pie segments, compared with all the examples on the opposite page.

A third dimension may be added to give the pie the impression of being solid, in the same way that the fever and bar can be treated. In this example, where it was possible, the percentages have been placed within the segments. The change in the total size of the labor force between 1979 and 1995 is reflected in the overall size of the circle.

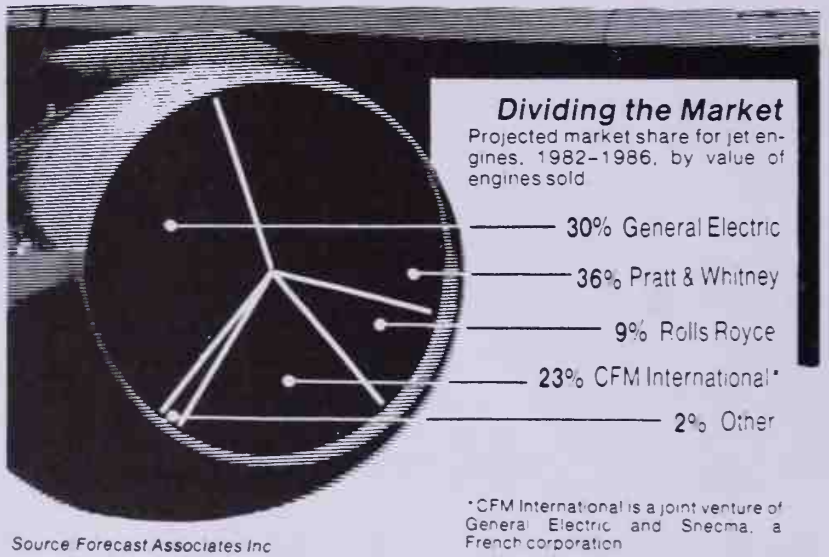




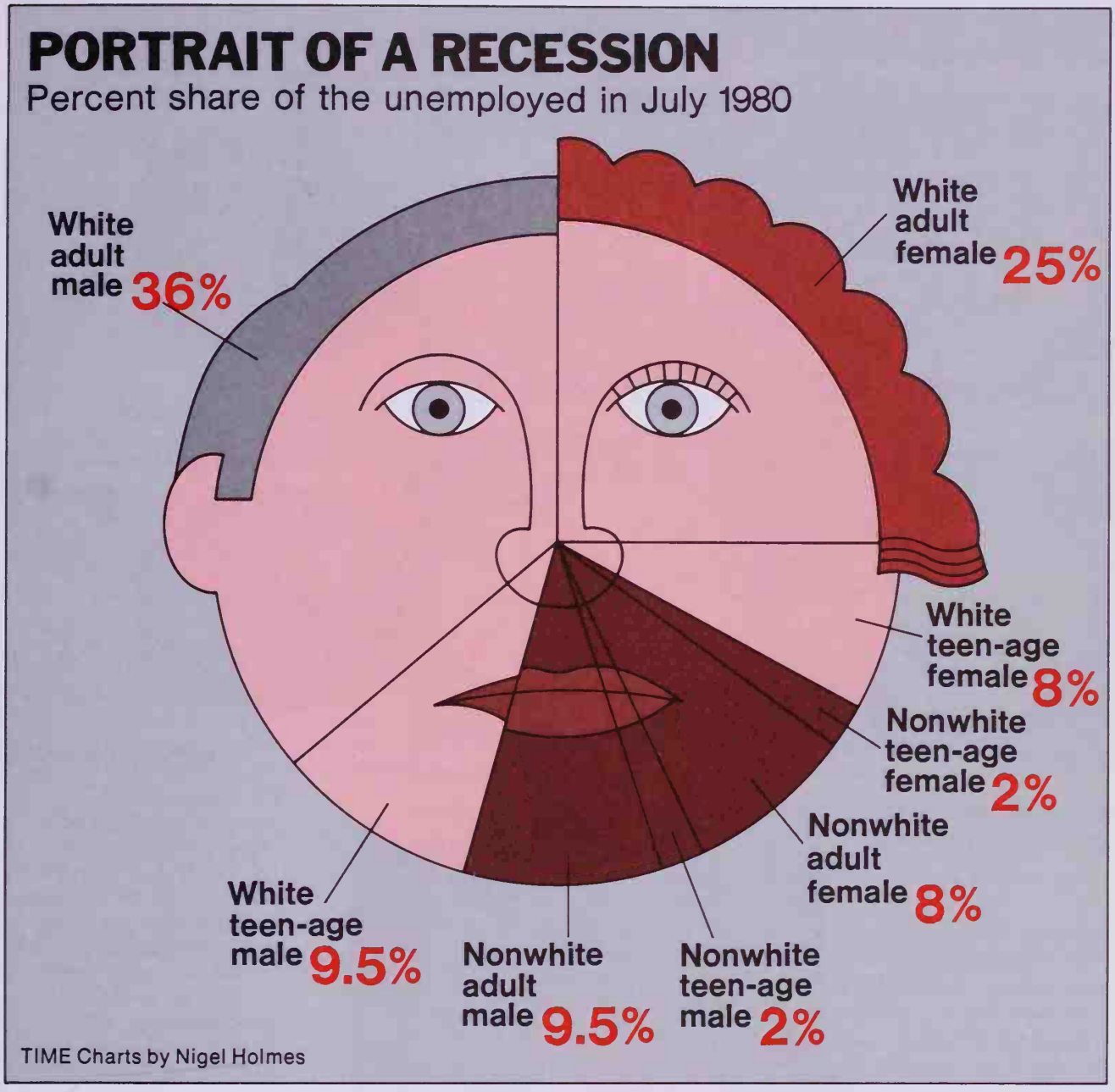
The noncircular pie chart could in some cases be seen as an example of a bar chart. It is included here, however, since it falls within the definition of a pie—a division of a shape into percentages. This example adds a little dimension and symbolism, thus showing the breakdown of voting patterns in England very clearly.



In this example of a noncircular pie the familiar Bendix logo is divided up to show revenues in 1977 and again in 1982.

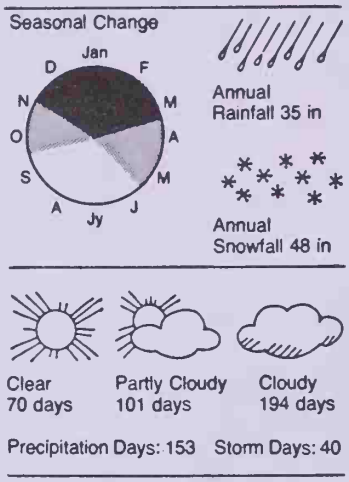


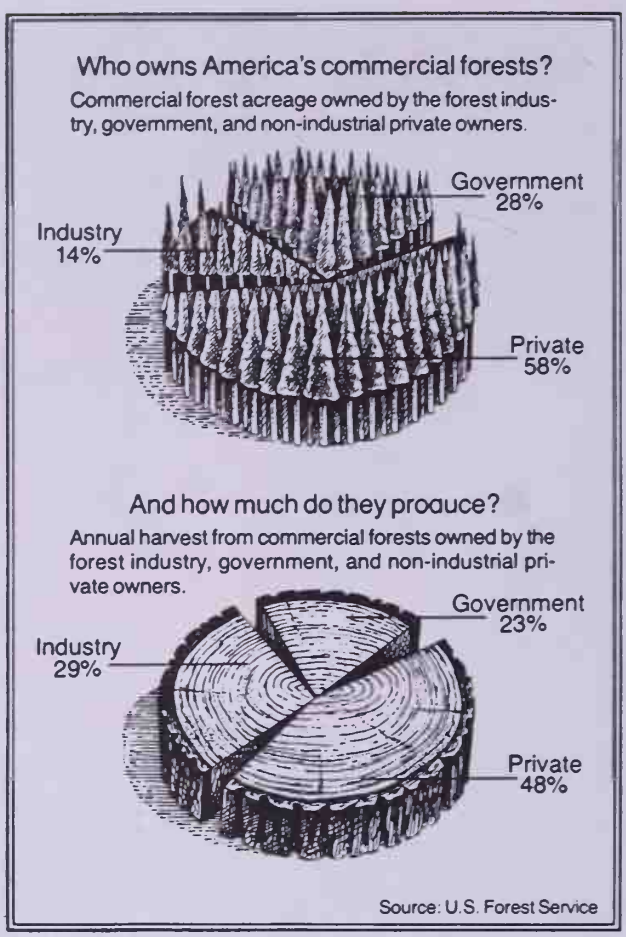
Taking the liberty of drawing the circle in perspective in previous examples, it could now become the top of a bottle, the wheel of a car, or another pictorial symbol appropriate to the subject of the chart. Set into the jet engine of an aircraft, this pie is simply achieved, but makes the point immediately.



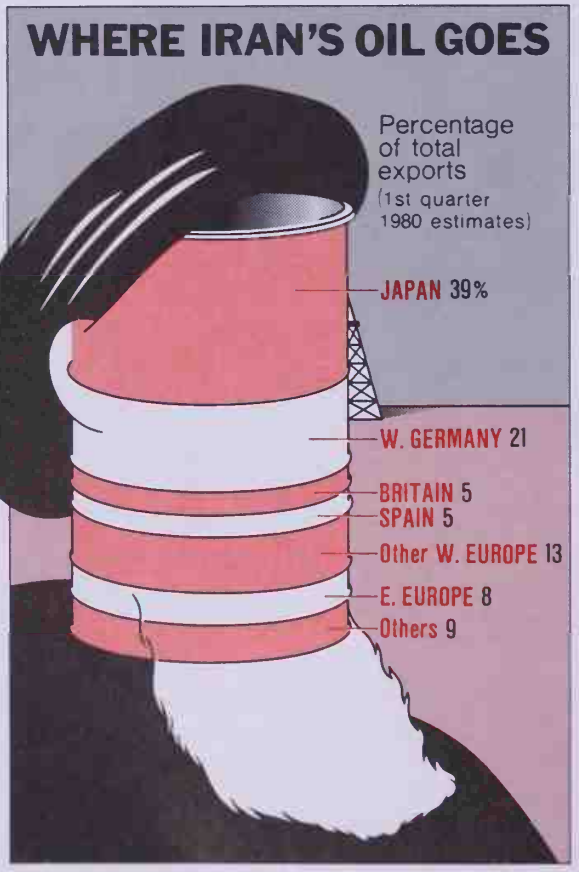
Illustrations may be inserted into the segments either to make up a whole (for instance, a face) or simply to show the content of each segment. The "portrait of recession" colors in the parts of the face in a way that is appropriate to the data being presented.

A variation of the pie as a device to record percentages of a whole is shown here with the circle representing a year with the months marked around it. This can then be used to record activities or other data for the year. Here the length and timing of the seasons are recorded. Dark gray is winter, light gray is spring or autumn, and white the summer.

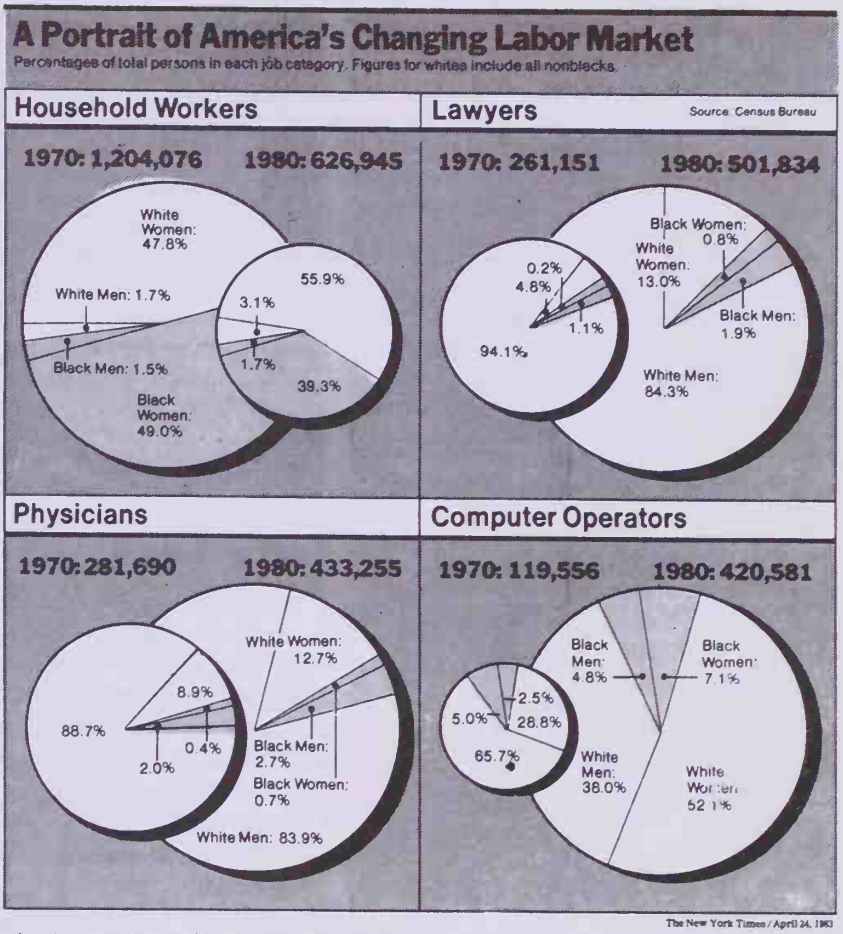




For a chart about tree growing, what could be more appropriate than a section through the tree itself! This image has the added advantage of being a known object (unlike the jet engine, which seldom has a chart inside it!), and the divisions are neatly made into axe cuts, or splits in the wood, emphasizing the "truth" of the picture.



In this example of a noncircular pie chart, Iran's oil output is symbolized by a barrel made into the face of a leader who had not yet outraged the world with his actions over American hostages.



The labor market is the subject of this group of charts that show in the most obvious way the distinction between black and white workers. The more complex data here has made the labeling somewhat harder to follow, but a little study reveals much information.

4. What Are Appropriate Uses?

Budget breakdowns, share of the market, income and spending figures are all good uses of the pie chart. However, no more than eight segments of the pie should be attempted.

5. What Are Inappropriate Uses?

If there are more than eight divisions of the whole the slices become too small to be visually separate. If a slice is under 2 percent it will be very tiny, and it is justified only if it is a single statistic among larger amounts. Then the point will be visually compelling. It will, however, be hard to label and could lead to inconsistency. If there is too much to be said about each segment, meaning that the designer has to put sentences of type outside the pie, the chart should be reviewed: either edit the copy or consider the pie chart an inappropriate form.

In a noncircular pie chart—for instance, a map of the United States divided nongeographically to show, say, the ages of the population—make sure that the outline map is greatly simplified, or you run the risk of leaving an unclear impression of the figures involved. Too complicated a shape—one that departs too much from a circle—should be avoided as an image.

6. What Are the Main Requirements?

Devices can be bought that divide circles into percentages. Obviously they will save you a great deal of time and thus are an essential part of your equipment. Careful attention must be paid to the design of the pie chart, especially the planning of the type. Where possible this should go inside the segment it labels, but in cases where this is not possible a logical system for the position of the labels should be devised. As with most graphics: the simpler the better.

For a review of the materials and techniques available to choose from, see the appropriate discussion under the fever chart.

THE TABLE

Tabulation of information is the oldest form of graphic presentation. Indeed all the information that William Playfair used and charted was, before his invention of the fever, bar, and pie charts, printed in the form of tables.

In fact, a table is not a visualization of statistics at all. The fever, bar, and pie apply a graphic form to the statistics. They change one number into a shape that can be visually compared with another. The table, however, presents the number as a number, plain and simple. There will be many occasions when the designer will need this method of presentation, rather than the three already dealt with in this chapter.

To understand the special characteristics of the table, study the six questions that follow.

1. What Is the Definition of a Table?

An arrangement of information, often numbers, into columns or other organized ranks or groups is the basic feature of a table. There is no attempt to represent any of the numbers by a pictorial form.

2. What Are Its Main Elements?

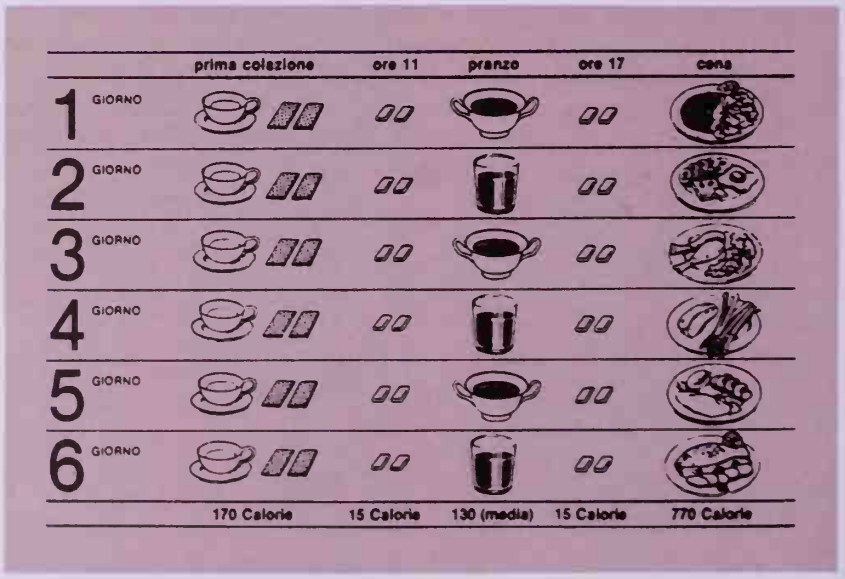
The numbers, statistics, or facts themselves, with a heading to define or explain them, are the main part of any table. These numbers may be all that is necessary in a simple example, but as the information to be put across becomes more complex, a second element may have to be used: that is, a grid of lines or framework into which the numbers can be placed. At its simplest, this device helps the eye follow one column of figures across a table containing many columns. It helps one see which figures are related to each other and where a new group starts.

A secondary use of the grid is also to introduce a pictorial element into the table. Thus, the parallel bars of a prison cell door may be used as the grid to contain statistics about prison populations. The door is the frame and the internal grid for the table, and its presence also gives the reader an immediate clue as to the subject of the information about to be read.

3. What Variants Are There?

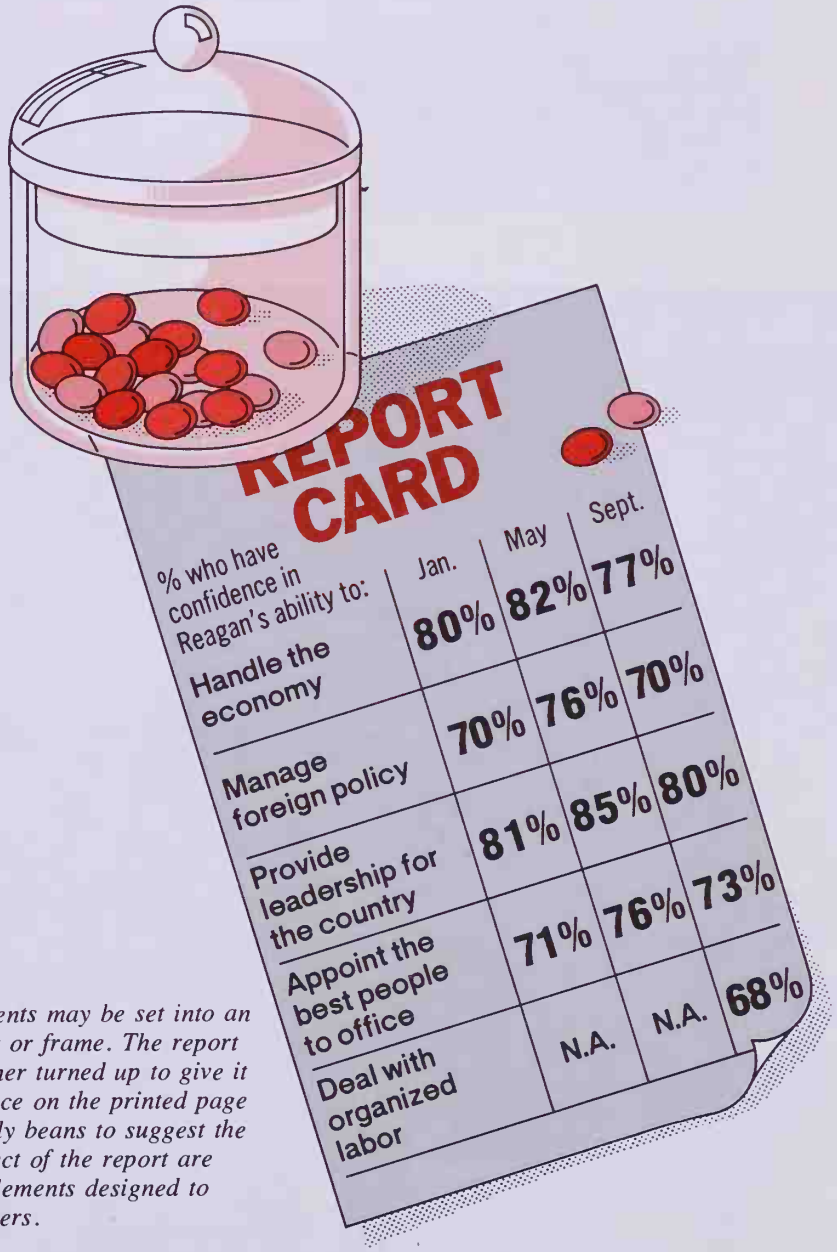
The table is responsible for mopping up many otherwise unclassifiable forms of graphic information. A typeset table of columns with headings and numbers is a table, of course, but so is a family tree, a calendar, or the index to a book. Shown here are the main variants.

Occasionally, symbols may be able to translate words into a truly international language. This table about an Italian diet food neatly substitutes drawings for words at each meal.



THE CARIBBEAN				
MAGIC ISLE Haiti	**PUNTA CANA** Dominican Republic	**CARAVELLE** Guadeloupe	**FORT ROYAL** Guadeloupe	**BUCCANEER'S CREEK** Martinique
18	16	22	24	20
			PIGEON	
			PIGEON	

A matrix of boxes with a vertical column of activities on the left and a horizontal list of locations across the top can be called a "what's available" table. The boxes can be filled in, or left blank, to indicate the occurrence of an activity (or the lack of it) at a particular location. In this example, symbols have been used to great effect to enliven a large table about holiday resorts. Although all that is needed to indicate the occurrence of an activity is a simple dot or check mark in the box, the designer's use of pictorial symbols instead nicely helps the eye and the mind distinguish different activities.



Simple arrangements may be set into an illustrated border or frame. The report card with its corner turned up to give it a physical presence on the printed page and the jar of jelly beans to suggest the presidential subject of the report are merely graphic elements designed to contain the numbers.

SICK SYSTEMS total passengers in millions/adult cash fare

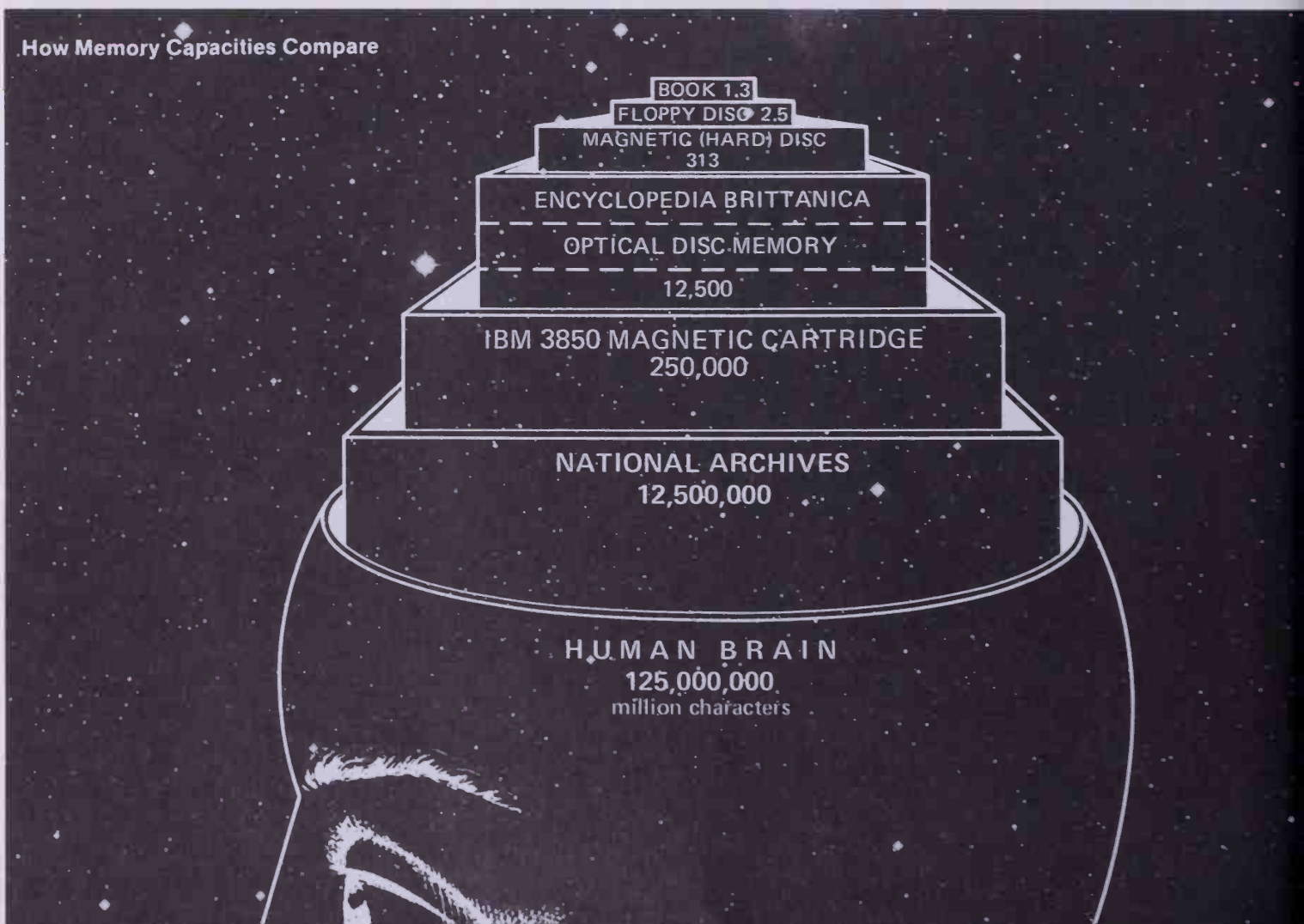
	1950	1955	1960	1965	1970	1975	1980
New York†	2,334/10¢	1,778/15¢	1,782/15¢	1,830/15¢	1,667/30¢	1,469/35¢	1,327/60¢
Chicago	1,325/15¢	990/20¢	847/25¢	792/25¢	661/45¢	650/45¢	692/80¢*
Philadelphia	828/12¢	622/18¢	568/22¢	419/25¢	274/30¢	314/35¢	330/65¢
Boston (subway; bus)	494▼/15;10¢	288/20;15¢	256/20;15¢	265/20;10¢	254/25;20¢	245/25;20¢	280/50;25¢
Detroit	332/15¢	216/20¢	130/25¢	112/25¢	112/40¢	77/45¢	70/60¢
Los Angeles	321/10¢	187/17¢	167/15¢	193/25¢	199/30¢	218/25¢	353/65¢
Baltimore	288/15¢	168/18¢	125/25¢	116/25¢	78/30¢	127/30¢	115/50¢
Pittsburgh	272/15¢	137/20¢	94/27¢	104/30¢	104/35¢	110/40¢	106/75¢
San Francisco	250/10¢	200/15¢	202/15¢	198/15¢	201/25¢	170/25¢	295/50¢
Atlanta	N.A./10¢	91/15¢	74/20¢	71/25¢	65/35¢	75/15¢	119/50¢
U.S. TOTALS	17,246	11,529	9,395	8,253	7,332	6,972	8,228

†Does not include transfers
*January 1, 1981
▼1951 figure

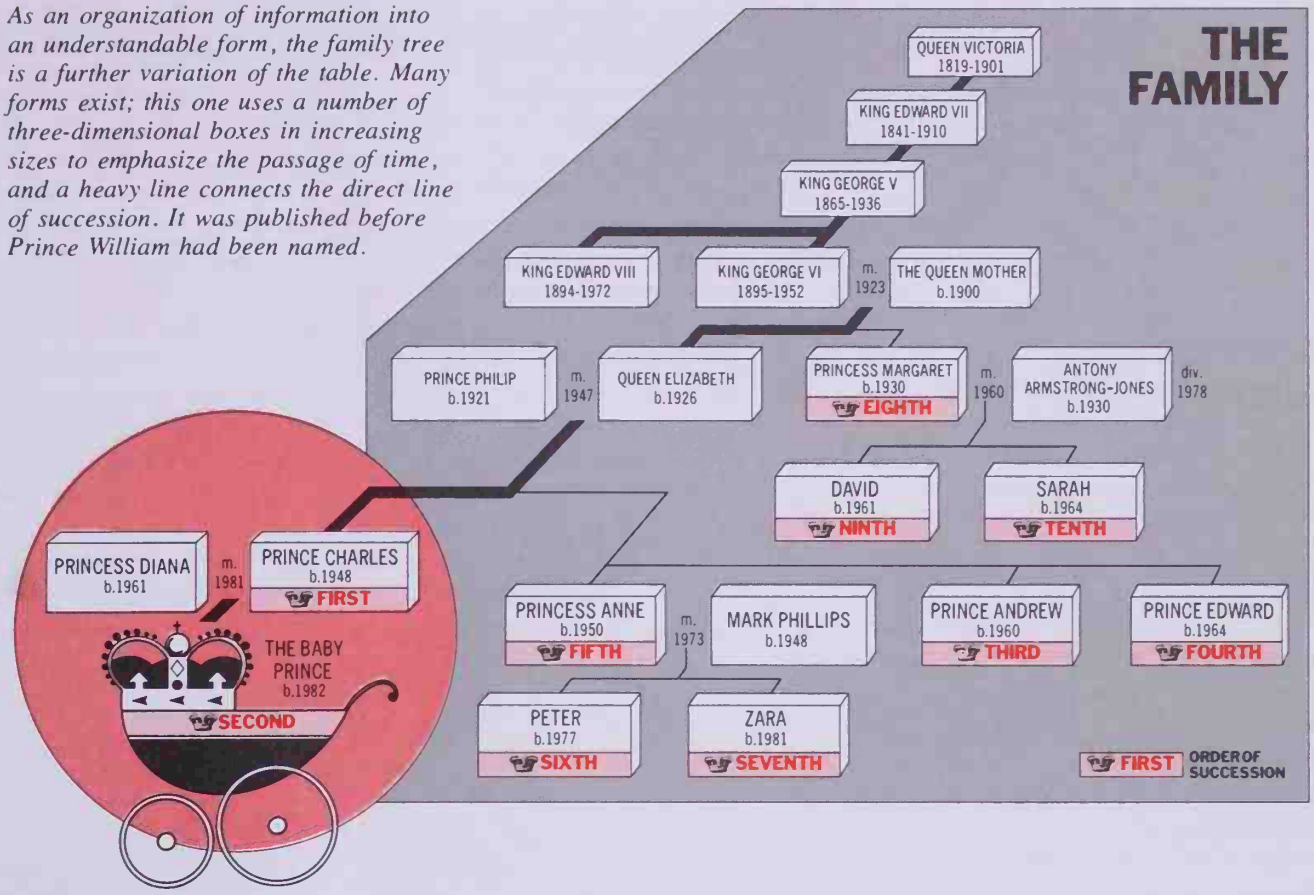
Source: American Public Transit Association and local transit systems
TIME Chart by Nigel Holmes

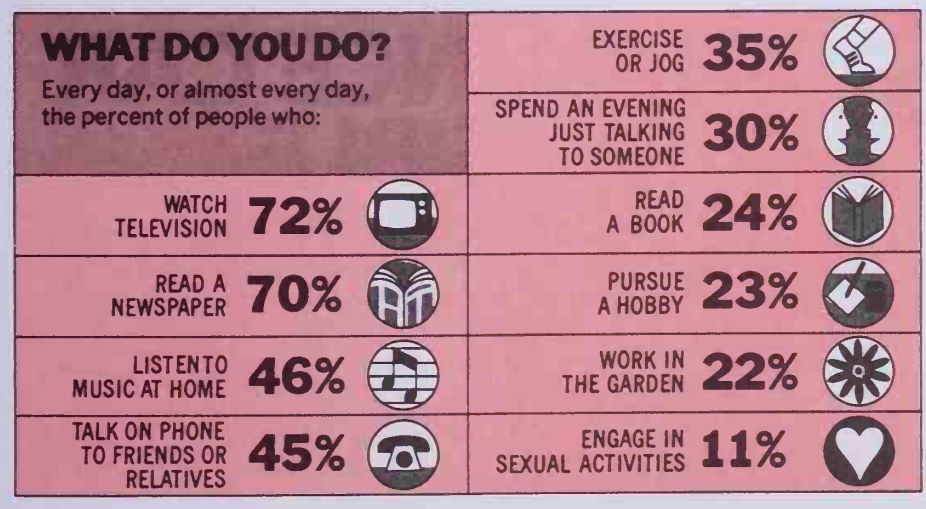
(Above) The box containing the table may become an illustration in itself. For a table comparing the costs of transportation in various cities around the United States, the whole table has been turned into a vehicle, slanted at the same angle as that of the italic type inside the boxes to accentuate the feeling of movement.

(Below) The whole table may be set over a photograph, in this case one which gives a generalized idea about the "future" rather than a specific one about the subject. A number of tables and charts were used in this booklet about computers and the future of the office; photographs of space, galaxies, and the planets provided different but consistent backgrounds.

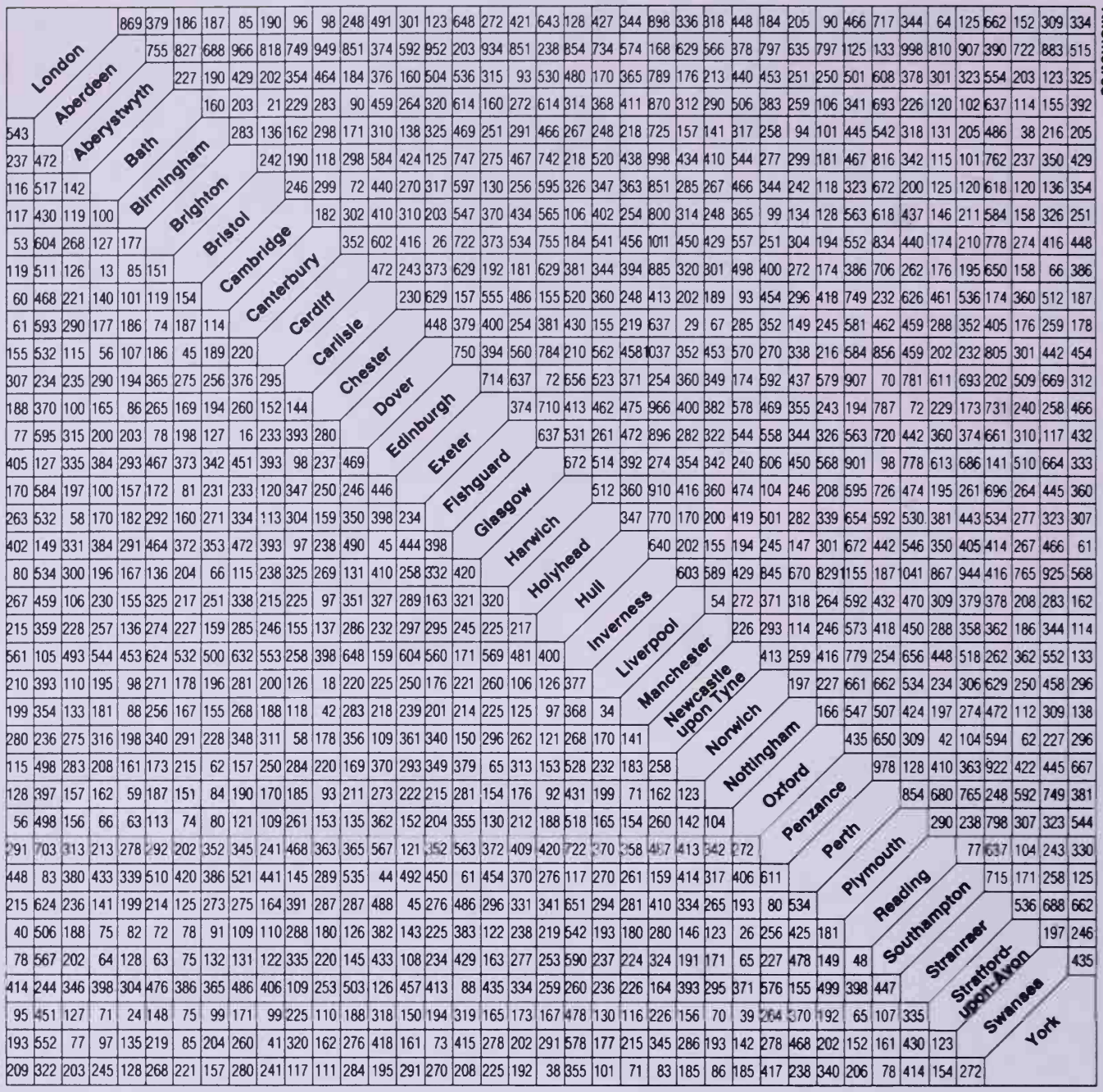


As an organization of information into an understandable form, the family tree is a further variation of the table. Many forms exist; this one uses a number of three-dimensional boxes in increasing sizes to emphasize the passage of time, and a heavy line connects the direct line of succession. It was published before Prince William had been named.

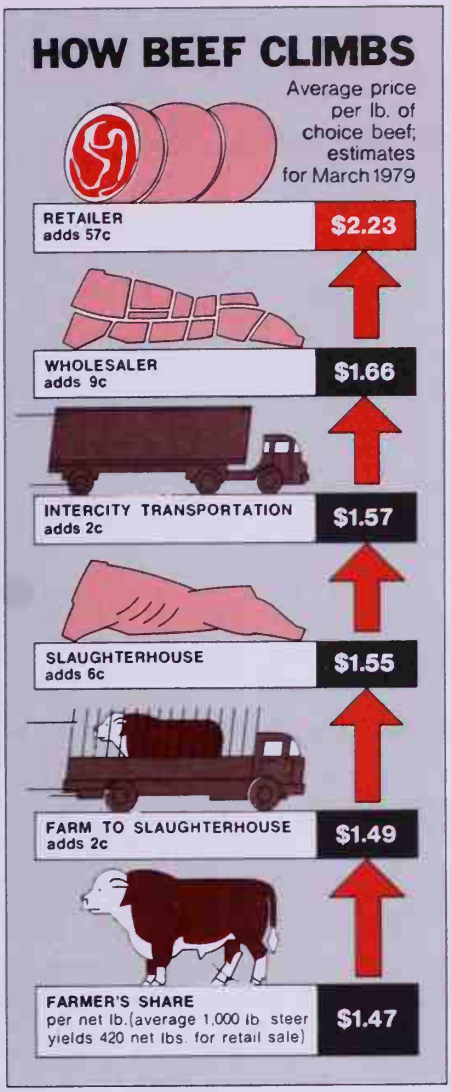




Here a symbol or symbolic illustration can be effectively used alongside each separate entry in a table.



A distance or mileage table is based on a matrix that indicates the distance between any of the places listed. In this elegant and compact example from England, the distance can be read in either miles or kilometers.



Where stages in the development of the subject of a table can be clearly identified and drawn, a further variant is to increase the amount of illustration so that it plays a role equal to the numbers. This obviously uses more space, but also helps the reader understand the meaning of the table. Here the increase in the price of a pound of beef is broken down into stages, with a little illustration to show the form of the meat at each one.

4. What Are Appropriate Uses?

There are at least six ways to use the table to best effect:

1. Where there are great differences between high and low numbers in a series that would otherwise be plotted, it is appropriate to set the figures down as a table rather than try to find a scale that will enable them to be charted.

2. Where there is a great amount of information, it is usually more space saving to set out the facts in type as a table.

3. Where different types of information are listed alongside one another, and thus where charting them alongside one another would be a pointless visual exercise, use a table.

4. Where it is necessary to read the exact numbers or quantities in a given set of statistics, the table is the only way to be sure that this is achieved. More than one decimal point, for instance, can never be seen on a chart, unless the scale is so minutely ruled out that it runs the risk of being confusing.

5. If after plotting out a multiple-line fever chart, the resulting shape is a tangle of criss-crossing and intersecting lines that looks, and therefore is, confusing, it is appropriate to tabulate the material for clarity.

6. Certain forms of graphic information just *are* tables. Calendars, timetables, duty rosters, family trees, frequency diagrams are what they are. There is no point in trying to force a different form onto the material. The designer's time and energy should be spent making them legible, elegant, and approachable.

5. What Are Inappropriate Uses?

When the statistics are so simple that they can be plotted out in a time series, you would be missing a graphic opportunity not to do so. The visual impact of the figures when charted, especially if those figures are themselves rounded off or generalized, is far greater than a dull listing of them in type.

6. What Are the Main Requirements?

The table communicates information only through the figures themselves, not through any other visual means. Therefore it is advisable always to present, even at a rough stage, the table in properly set or typewritten type, not as handwritten numbers. Since many typewriters have quite sophisticated tabulation functions, this may be achieved relatively easily, with a little effort and time. As for the finished art, the main cost element will of course be the typesetting. Since the nature of tables is to be able to handle large amounts of information, your type bill will certainly be higher than for any other type of chart.

While you consider various ways to achieve readable tables, review the discussion of materials and techniques under the fever chart earlier in this chapter.