

Rochester Institute of Technology

RIT Digital Institutional Repository

Theses

5-1-1989

Visual metaphors in computer-generated information graphics

Sidney E. Jablonski

Follow this and additional works at: <https://repository.rit.edu/theses>

Recommended Citation

Jablonski, Sidney E., "Visual metaphors in computer-generated information graphics" (1989). Thesis. Rochester Institute of Technology. Accessed from

This Thesis is brought to you for free and open access by the RIT Libraries. For more information, please contact repository@rit.edu.

Rochester Institute of Technology

*A Thesis Submitted to the Faculty of
The College of Fine and Applied Arts
in Candidacy for the Degree of
Master of Fine Arts*

Visual Metaphors in Computer-generated Information Graphics

*by
Sidney E. Jablonski*

May, 1989

Approvals

Chief Advisor: Robert Keough

Date: 5-31-89

Associate Advisor: James Ver Hague

Date: 5/31/89

Associate Advisor: Jack Slutzky

Date: 6/6/89

Special Assistant to the Dean for Graduate Affairs:

Philip Bornarth

Date: 6/12/89

Dean, College of Fine and Applied Arts:

Robert Johnston

Date: 6/20/89

I, Sidney E. Jablonski, hereby grant permission to the Wallace Memorial Library of RIT, to reproduce my thesis in whole or in part. Any reproduction will not be for commercial use or profit.

Date: May 31st, 1989

Contents

1. Introduction

2. Chart Pioneers:

3. Key Components:

a. visual metaphor

b. computer graphics

4. Body of Work:

study one: Overnight Mail

study two: Herbal Tea

study three: Flying Tiger

study four: Asian Students

study five: Aluminum Bats

5. Conclusion

6. Endnotes

7. Bibliography

Visual Metaphors in Computer-generated Information Graphics

Introduction

The subject of this thesis investigation is in the category of informational graphics, or 'Infographics' as coined by industry pundits.

Being a relatively new graphic phenomenon, a precise definition of an 'Infographic' seems elusive. There is general agreement, though, that the 'Infographic' owes its beginnings to the field of statistics and the charting techniques which subsequently arose.

Still, while contemporary 'Infographics' often involve charting of statistical data, one finds that

illustrated diagrams and maps are also lumped into this category. The result is a broad-based term which has grown to include such things as stock-market charts, weather maps, and technical illustrations of airplane crashes.

Regardless of the rather imprecise terminology, the 'Infographic' has become a common sight to readers of magazines and newspapers.

The way 'Infographics' communicate to those readers can occur at various levels of sophistication. That is, the approach can be direct, as in a

Introduction

basic chart or graph with rising and falling lines or bars; or it can be pictorial, as in a chart or graph which uses illustrative elements to either substitute for, or augment traditional lines or bars.

The aesthetic aim of the following investigation was to present information graphics in a visually arresting manner. The inherent challenge was devising charts and graphs which went beyond the austere traditions of the past by integrating visual metaphoric elements as design components.

Therefore, this report explores the use of the visual metaphor in 'Infographics' as a calculated communications tool and shows, by comparison to standard presentation methods, how statistical figures can be dynamically portrayed.

The developmental stages for each infographic are also documented. A structured methodology beginning with an interpretive

matrix—a semiotic device used to list possible visual representations—was employed to augment the conceptual stages.

The task of creating a four-color graphic on the Macintosh microcomputer (manufactured by Apple Computer Inc.) is explained and followed all the way to the final output on a Linotronic 500 laser imagesetter (manufactured by Linotype AG).

In general, a basic understanding of computer technology on the reader's part is presumed. The following accounts often mention various software programs, computer hardware and peripherals and methods of handling computer graphic images, each of which could inspire a lengthy discourse.

Therefore, lest this report digress into a technical manual—of which there are many already in existence—emphasis will center on aspects relevant to the immediate discussion.

This project was inspired by the creative use of information graphics in *TIME* magazine and *USA TODAY*, particularly by Nigel Holmes who heavily contributed to the prevalence of illustrated charts and graphs in *TIME* magazine during the 1970s and 1980s. ■

Chart Pioneers

History

To understand the beginnings of 'Infographics' one needs to look back to the origins of charts. Nigel Holmes, in his book *Designer's Guide to Creating Charts & Diagrams*, traces chart history back to the 1200s. Although he credits the Egyptians, Greeks, Chinese and Japanese for laying important groundwork, Holmes' account maintains that the modern trend in chart evolution should begin with English scientist Roger Bacon because:

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.¹

After Bacon, the next person credited with important contributions was Thomas Bradwardine at Oxford. In the early 1300s Bradwardine, by using algebraic letters and symbols:

... laid the foundation for the next natural step—representing one function and its relation to another function by the use of graphs.²

Meanwhile, contemporaries of Bradwardine were making strides in Paris. They were Albert of Saxony, Marsilius of Inghen, and particularly Nicole d' Oresme, Bishop of Lisieux.

History

Oresme (1325—1382), states Holmes:

... discovered the logical equivalence between the organization of figures into groups and the graphing of those figures.³

In fact, it was Oresme who actually produced the first graphs.

Rene Descartes (1596—1650) contributed the system of intersecting lines known as the 'Cartesian grid.' Descartes established his system in an addendum to his book *Discourse on the Method of Rightly Conducting the Reason and Seeking Truth in the Sciences* (pub. 1637).

It was Descartes' use of two lines—one horizontal and one

vertical—with segments marked off was the forerunner of today's graph paper. As Holmes remarks:

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.⁴

In the late 1700s the brothers John and William Playfair are credited with inventing modern methods of visualizing statistical figures. William Playfair in particular is today recognized for creating the fever chart, pie chart, and perfecting the bar chart.

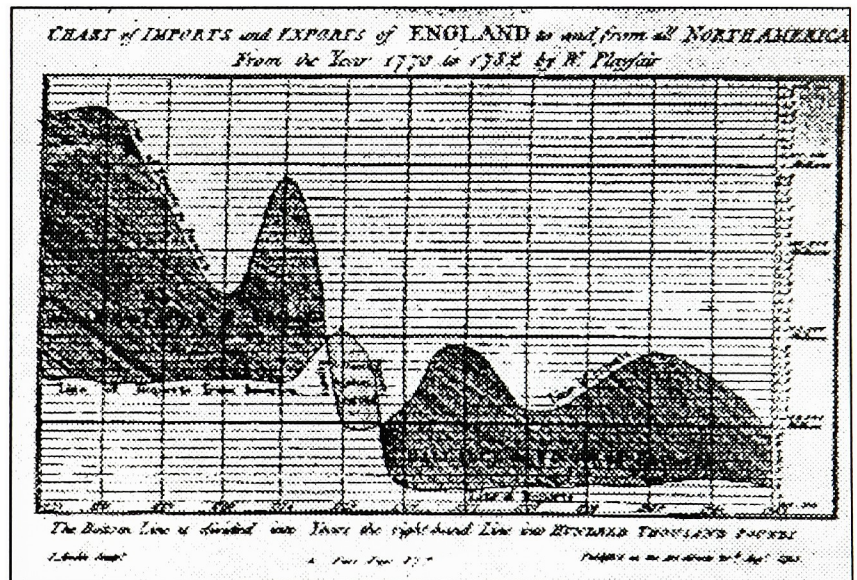
William Playfair received an early training in engineering and

other practical sciences. From this early training he became skilled in technical drawing which eventually contributed to his development of innovative charting methods.

In addition to his scientific training, a desire to become an author led Playfair to publish many of his statistical discoveries.

In 1786 at age 25, Playfair published the *Commercial & Political Atlas*. In this publication alone Playfair is credited with perfecting the bar chart and the fever graph. Playfair is quoted as saying:

The advantage proposed by those charts, is not that of giving a more accurate statement than by figures, but it is



An early fever chart from Playfair's *Commercial and Political Atlas* published in 1785.

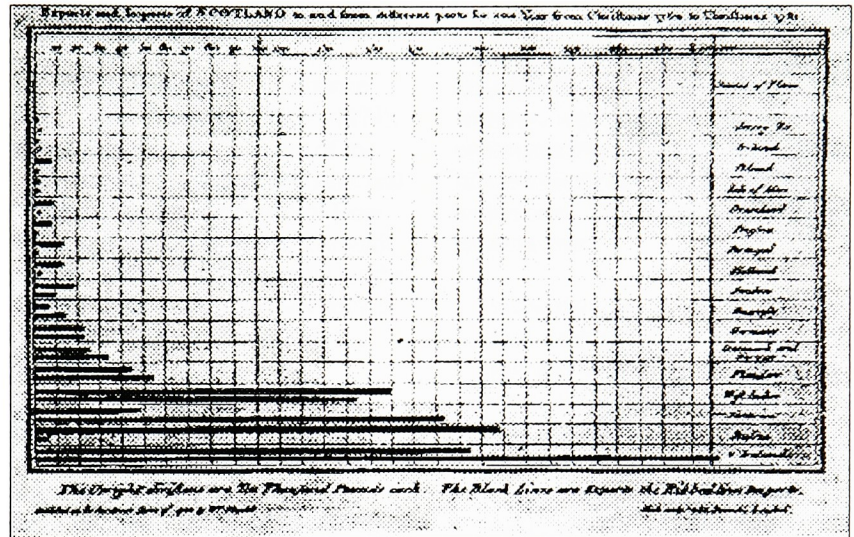
History

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.⁵

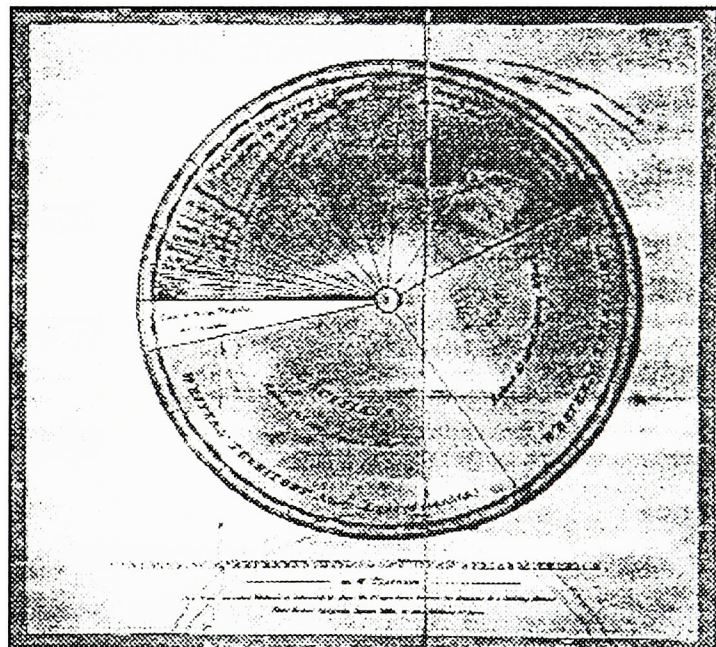
Aside from the changes in typography, fewer graphs today are still drawn in the manner invented by Playfair.

The other type of chart perfected in the *Commercial & Political Atlas*, was the bar chart. It is noted, however, that the bar chart was the one form of statistical presentation used by Playfair which he did not actually invent.⁶

In 1805, in *The Statistical*



Above: Early bar chart from the *Commercial and Political Atlas* (second edition, 1787). Below: The first published pie chart, from the *Statistical Account of the United States of America* (1805).



History

Account of the United States of America, Playfair introduced what was termed the 'divided circle.' The idea behind the so-called 'divided circle' was to show percentages of a given whole as 'slices' of a circle. This type of chart was destined to be the principle of the modern pie chart commonly used today.⁷

William Playfair, however, divided his energies between an early scientific and engineering direction, and a later effort to become an author. Playfair thus failed to achieve due recognition because, as Holmes writes:

[he] . . . 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.

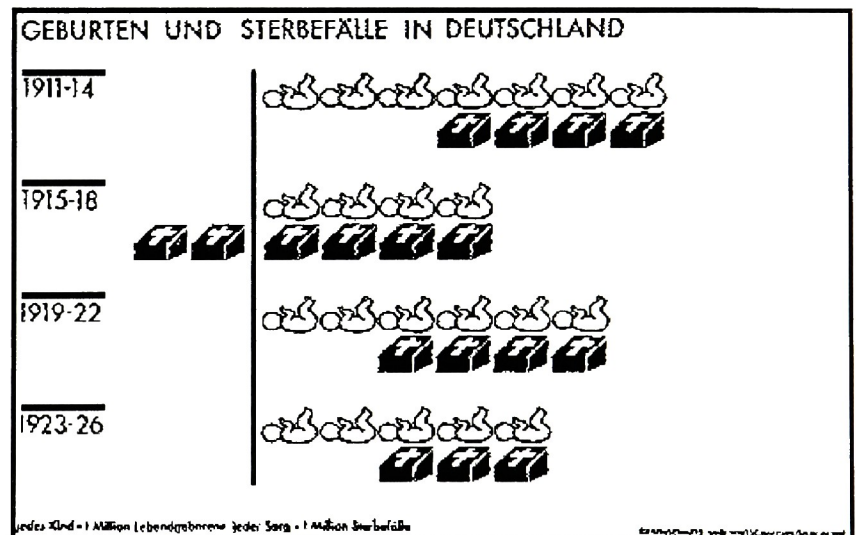
He is almost unknown today.⁸

The next name of importance was Jacques Quetelet (1796—1874). Quetelet served as President of the Central Commission of Statistics and initiated the first International Congress of Statistics in 1853. Through his 65 books and major papers on the subject of statistics, Quetelet helped establish statistics as a bona fide science.⁹

In the 1920s, major contributions to charting came out of the 'Vienna Museum of Social and Economic Studies' in Austria. The museum, under the direction of Dr. Otto Von Neurath developed its so-called 'Vienna Method'; an austere approach that embraced pure functionalism. Under Dr. Neurath's guidance, the museum worked on the development of a picture language

called 'Isotype' (International System of Typographic Picture Education). The symbols, called isotypes, were meant to work as communication tools which people of any culture or language could understand. The museum described its aims thus:

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.¹⁰



A chart from the Vienna Museum of Social and Economic Studies shows the Isotype picture language in use.

History

The 'Vienna Method' quickly became noted for its rigid, systematic approach. The following characteristics became associated with it:

- Prohibition of all irrelevant, decorative elements.
- Objects and figures severely simplified into basic symbols.
- Repetition of symbols to show large quantities.
- Three-dimensional styles avoided in favor of a two-dimensional visual style.
- Color used in a calculated manner to communicate information.

Of the 'Vienna Method,' Jan Tschichold wrote in 1931:

the most important thing in the work of the museum is the systematic emphasis laid on essentials, and expressed in

pictorial symbols universally intelligible, valid as international currency.¹¹

About the same time Dr. Neurath was making advances in Austria, charting became noticed in America. After the stock market crash of 1929 many became involved in predicting market behavior based on historical data shown in charts. Soon thereafter began the regular appearance of charts in various American publications.¹²

Despite the impact of the Vienna Method, by the 1950s austere, functionalism began to give way to more dynamic imagery. For instance, from West Germany came examples of charts which employed the three-dimensional style shunned by Neurath and his followers. The three-dimensional style of the 1950s, according to Holmes, "... was a forerunner of the more illustrated

charts developed in the 1970s."¹³

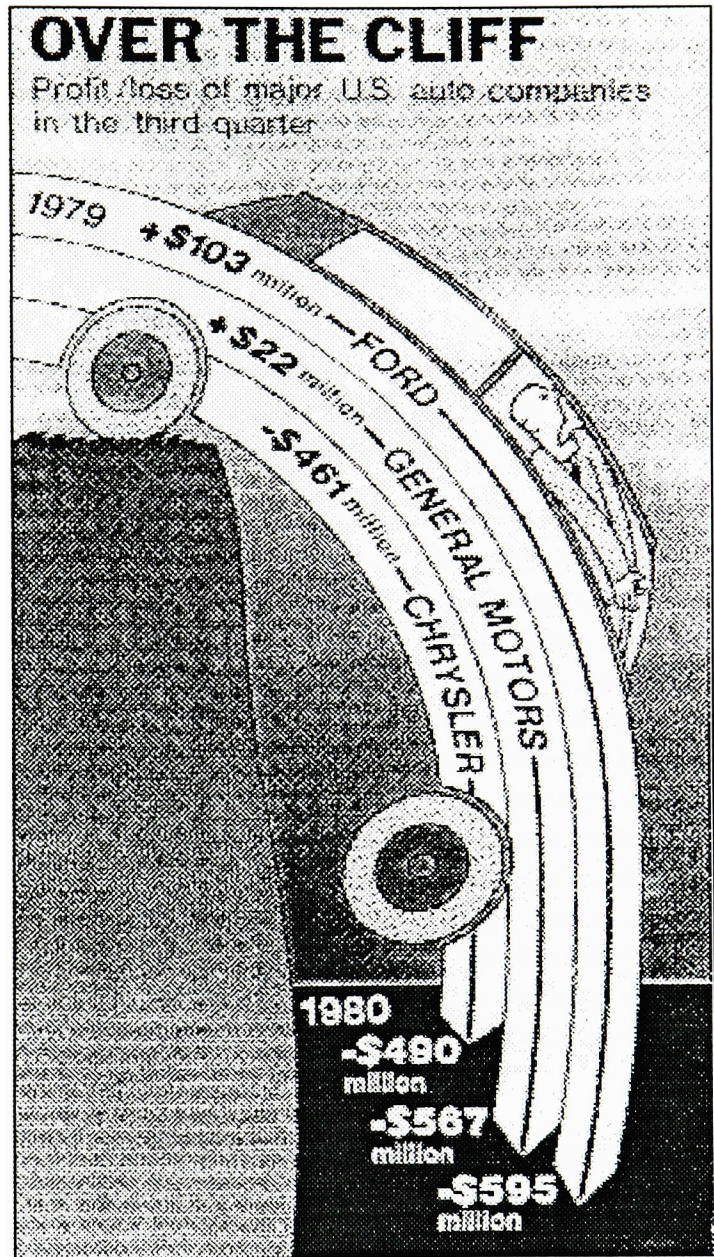
Indeed, it was Holmes himself whose work at *TIME* magazine contributed greatly to the evolution of illustrative charts and graphs. Holmes' work moved chartmaking beyond simply being graphic evidence of data. As Holmes himself wrote:

A simple chart is no more than a set of statistics made visible. . . . 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.¹⁴

Holmes' work, it should be noted, did not reject the methods used by earlier pioneers for traditional methods did appear in his work. But it was all those bent and distorted bar, fever and pie charts that marked a departure from the past. Holmes regularly included illustrative elements in his charts. Yet it was not uncommon for those elements to become, not backgrounds or decorative icons, but the charts themselves.

Holmes created charts which attracted attention and conveyed information quickly. As other



The charts of Nigel Holmes sought to interpret as well as present figures in an engaging manner.

publishers also adopted the use of illustrated charts, the term 'Infographics' emerged. Much of this may be due to the successful use of illustrated charts at *USA TODAY* which broke new ground for newspaper graphics. Many *USA TODAY* emulators have since joined the bandwagon resulting in the profusion of infographics which exists today. ■

Current Trends

As more and more publications began to use charts, graphs and diagrams, the infographic phenomenon established itself—especially in newspapers.

Following the lead of *USA TODAY*, many newspapers have and continue to adopt infographics to satisfy the growing emphasis on eye-catching visuals. George Garneau, in an October, 1988 article in *Editor & Publisher*, wrote:

Newspaper editors overwhelmingly see informational graphics as a growth industry on news pages into the next century . . . "These are the glory days of informational graphics and there is no end in sight," Howard I. Finberg, assistant managing editor of the *Arizona Republic*, said in a report on his study at the American Press Institute's Montgomery Curtis Memorial Seminar recently. . . . He suggested the survey shows editors have recognized the potential of infographics as "a new and dynamic way of attracting and keeping readers . . ." [but to maintain quality, Finberg mentioned the] . . . need to break through the barriers that separate visuals and words and look at the presentation of information as the ultimate goal . . . ¹⁵

Assessing the infographics' long-term prospects, Garneau proclaims that, in his estimation, the infographic movement is not a fad. ■

Key Components

One: Visual Metaphor

A visual metaphor is an image in which one kind of object or idea is used in place of another to suggest a likeness or analogy between them.

Visual metaphors incorporated into a graphic can attract attention and convey information more effectively than a plain chart or graph. The tradeoff between using visual metaphors vs. plain charts is that plain charts tend to present raw numbers more clearly, while illustrative devices try to portray the subject matter better and make it memorable.

To incorporate a visual metaphor as an illustrative device demands more conceptual effort than the standard symbols and emblems typically employed in information graphics.

With information graphics, an

illustration may be abstracted so as to co-exist with a chart or graph, thereby becoming a visual metaphor. This act relieves the reader of the task of translating the statistical data and the subject matter. In other words, a visual metaphor suggests a sort of mental image for the viewer. It was exactly such a metaphorical treatment of charts which typified much of Nigel Holmes' body of work.

It may be true that if not carefully designed, the use of metaphoric devices can actually serve to obscure rather than clarify the data. Likewise, there is the risk of an 'Infographic' subtly suggesting prejudices. But, when properly executed, a visual metaphor is arguably one of the most effective ways to communicate information. ■

Two: Computer Graphics

As the use of infographics has gained popularity in numerous publications, another phenomenon has concurrently impacted on how graphics are produced in art departments. That phenomenon is the computer; or to be specific: the Apple Macintosh.

The use of computers to create graphics has become so prevalent that in leading organizations such as *USA TODAY*, upwards of 80 percent of the daily graphics are produced by computer techniques rather than by hand.

How did this come to be? Apple introduced the Macintosh in 1984, but it wasn't until the LaserWriter appeared in 1985 that it truly began

to exert an influence. The LaserWriter, "... was what made the Mac a tool newspapers could really use. Now there is no question it is a major force in graphics," says John Watson, deputy managing editor for graphics and photography at *USA TODAY*.¹⁷

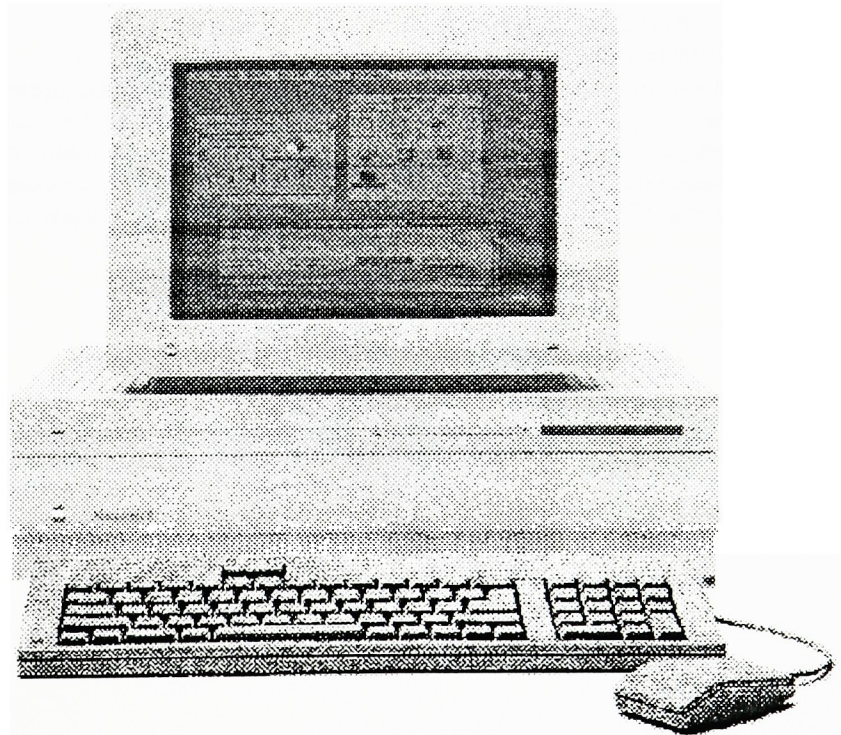
The LaserWriter's impact was due to its abilities to accurately manage complex graphics as well as text. The LaserWriter (as stated in *The Apple Macintosh Handbook*, p. 123) achieved its abilities by interpreting PostScript; a computer language specially designed by Adobe Systems, (Palo Alto, CA), to describe text and graphic images.

According to Jim Leeke, the

influx of the Macintosh did not just happen by osmosis. "The Mac's proliferation at top newspapers," says Leeke, "was also spurred by a few influential editors who realized its vast potential."¹⁸

One such editor, George Rorick of Knight-Ridder/Tribune News is quoted, "The Mac is a tool. Once you learn how to use it, you can save a tremendous amount of time and expense."¹⁹ The way the Macintosh accomplishes such economic benefits is in the following ways:

- Graphics can be easily edited as stories change because graphics are stored as data on magnetic disks.



Two: Computer Graphics

- Graphics can be transmitted by modem, thus linking artists around the country and allows a single graphic to appear in several publications the same day.
- Stock images can be stored in graphics libraries for unlimited reuse.²⁰

The LaserWriter, despite its important role in establishing credibility for the Mac, is falling into a secondary status. LaserWriters are still being used at many places but more and more only for proofing. As Leeke writes:

well equipped operations . . . use their LaserWriters only for proofing. They print camera-ready graphics on Varityper VT600s, Linotronics or other expensive, top-of-the-line printers and imagesetters.²¹

The next phase that many

newspapers are exploring is the implementation of computer processed color graphics. Writes Leeke:

Some run color already—*USA TODAY*, *Chicago Tribune*, *Boston Globe*—a few of them daily. Others including the *Los Angeles Times* and the good, gray *New York Times*, still appear entirely in black and white. But these papers, too, are planning for color in the next few years. “Color is the future,” said [graphics editor of the *Los Angeles Times*] Chaplin in Los Angeles. “Most newspapers will be heavily into color in the ‘90s.”²²

Of course, as one might expect, getting colors into print from a computer is somewhat complicated. Nevertheless, several software packages have recently been introduced which can perform color

separation chores.

The software programs most often used to create infographics are object-oriented draw packages. The industry favorites are MacDraw II, Adobe Illustrator, and Aldus FreeHand. Besides being equipped to create the basic drawing, these packages also have color separation capability; Adobe Illustrator and Aldus FreeHand being the most sophisticated choices.

What makes Illustrator and FreeHand the programs of choice for color is their use of the CMYK color model. The CMYK (cyan/magenta/yellow/black) model is the approach taken in specifying colors for four-color process separation.

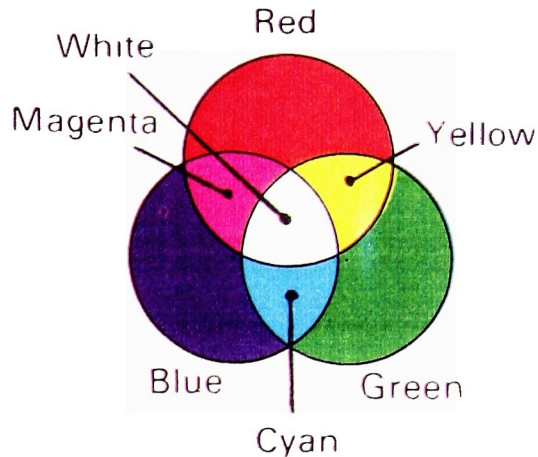
By contrast, other color models are red/green/blue (RGB), and hue/saturation/ brightness (HSB). RGB and HSB models are standard for color scanned images or any color image appearing on a computer screen. However, because printed color charts for RGB and HSB

Two: Computer Graphics

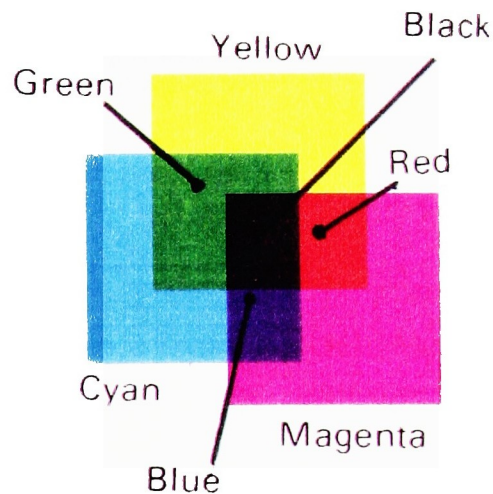
models do not exist, one cannot know what color the printed result—which requires the CMYK model—would be.²³

The reason printed color charts do not exist for RGB and HSB models stems from the differences between additive and subtractive color theory.

For instance, subtractive color theory deals with color resulting from the light waves absorbed and reflected by various pigments. The color seen depends on the color of light reflected by a pigmented object. The primary colors in subtractive color theory are cyan, magenta, and yellow, each of which, according to the theory, subtract a portion of the white light an object is exposed to. White light, of course, consists of all the colors of light in the visible spectrum. Therefore, the presence of all the primary colors should produce



Additive color



Subtractive color

Two: Computer Graphics

black whereas the absence of all primary colors should result in white.

In real life though, when printing inks are used to try to implement the subtractive color theory one finds that printing inks do not absorb all white light. The result is a brown color instead of black. To remedy this situation black ink is used to print areas which are to be black or shades of gray. This is where the cyan, magenta, yellow, black (CMYK) color model for printing derives from.

By contrast, the RGB and HSB color models are examples of additive color theory. According to the additive model, if the rainbow is divided into thirds, the primary colors turn out to be red, green, and blue. When these colors are added together they produce white instead of black as in the subtractive theory. Likewise, the absence of all colors would produce black instead of white. By varying the relative red, green, and blue intensities the

additive theory allows all other colors of light to be created.²⁴

As one might now anticipate, the task of accurately converting the RGB or HSB colors on the monitor screen to CMYK colors on paper has yet to be achieved.

Besides CMYK, the printing industry also relies on PMS (Pantone Matching System) color palettes. While also subtractive in color theory, the PMS system serves to bypass the use of four separate inks to create a color. This is accomplished by using one specially mixed ink for each specified color.

According to Steve Roth, the software programs for the Mac which provide PMS color libraries actually simulate PMS colors using CMYK. That is, PMS colors are typically printed as solid areas of ink.

CMYK—or process colors—require the printed image be broken up into tiny dots. A set of dots for each ink color is printed with each

dot screen slightly offset from the others. The eye then merges the ink colors which visually produces the desired color.

The problem here is that CMYK equivalents do not match PMS color guides. When producing color graphics on the Mac, the simple rule, says Roth, is: “Don’t use PMS palettes, and don’t use RGB or HSB if you have CMYK available.”²⁵ ■

Body of Work

Infographic Studies

From the preceding discussion one can see how the creation of an infographic may force the designer to deal with technical as well as aesthetic problem solving.

The following work—a series of five studies—therefore has been an effort with a twofold aim.

Aesthetically, the work sought to explore an effective means to communicate information.

Technically, the challenge was to master and utilize the capabilities of the tools available to the designer.

Each study was an exercise implementing the visual metaphor as a tool for communicating statistical data. As one will see, for each case symbolic elements were chosen with attention given to the semiotic considerations involved.

In addition, a plain chart or

graph using identical data was also created in each study allowing a comparison between standard and metaphorical approaches.

Technically, the Macintosh computer was chosen because it has become a standard for graphics applications. Aldus FreeHand software was chosen for the task because it had CMYK color separation capabilities and its text handling features surpassed those of Adobe Illustrator. Proofing was done on a LaserWriter II NT at 300 dpi (dots per inch) resolution. But the higher resolution Linotronic 500 (1690 dpi) was used for printing color separation film negatives.

The Linotronic 500 is a high-quality laser imagesetter with a PostScript interpreter, capable of outputting integrated text and

Infographic Studies

graphics, tints, patterns and special effects.

For the following studies, the Linotronic output was put to film, but could also have gone on paper or press-ready plate. The Linotronic 500 is also able to process tabloid size (11" x 17") size documents enabling single, large-format displays for each infographic study.

Starting with the raw data, each study continues through various stages to the finished piece. The stages are: data collection, semiotic or symbol research, preliminary sketches, design revision, and computer processing/output. An analysis following each assignment comments on the findings particular to that piece. ■

Study one: Overnight Mail

Subject:

A test was conducted by *Business Week* magazine to compare the performance of various overnight delivery services. An infographic could show the relationships between the delivery times of the mail services tested.²⁶

Data:

An examination of the data determined that a bar chart would be the best format to use. Bar charts excel when the purpose is to compare individual or sets of figures as opposed to overall flow or time series. In this case the problem dealt with the visualization of the quantity of time used by individual elements.²⁷

Interpretive matrix:

After collecting the data, it was helpful to first make a list of possible symbols and symbolic elements

related to the subject (see next page). In order to aid in assembling such a visual vocabulary an Interpretant/Expression Matrix (or Interpretive Matrix for short) was used.

The use of such a matrix, in the words of Thomas Okerse, is:

... a device to identify, generate and evaluate possible representations from which to choose their appropriateness to the need.²⁸

The various elements of the Interpretive Matrix serve as a reference source for developing preliminary sketches.

Concept development:

This sketch (see bottom right) was made using several of the components listed in the interpretive matrix.

The idea was to have a bald

Average wait for a delivery (after 8 a.m.)

Emery Worldwide	1 hr., 31 min.
Federal Express	1 hr., 44 min.
Airborne Express	2 hr.
DHL Worldwide	3 hr., 2 min.
Purolator Courier	3 hr., 12 min.
U.S. Postal Service	
Express Mail	3 hr., 15 min.
U.P.S.	3 hr., 31 min.

Data: Business Week

Infographic Studies

eagle represent all overnight delivery services. The eagle was given a postal-worker's cap and shown lugging a mail parcel through the sky.

To further the message that these services truly provide over-night delivery, it was decided to use a night sky with stars and moon as backdrop.

The heart of the graphic, though, centered on the treatment of the eagle's wings. By drawing the wing feathers as long curvilinear bars, the eagle image and chart became one and completed the metaphor.

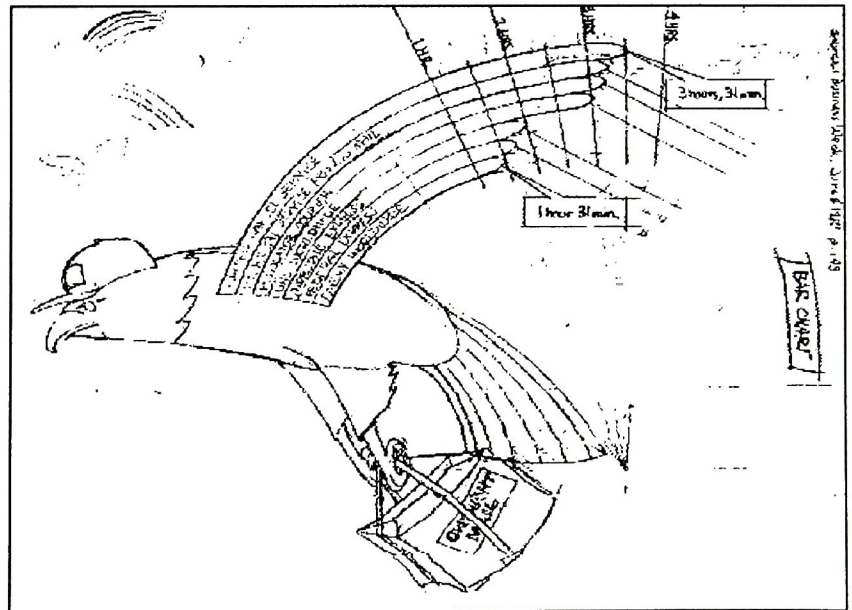
Revision and processing:

The next necessary step was to input the sketch into the computer. One method is to trace the sketch onto a piece of acetate, then tape the acetate onto the computer screen for use as a template.

The other method is to use a

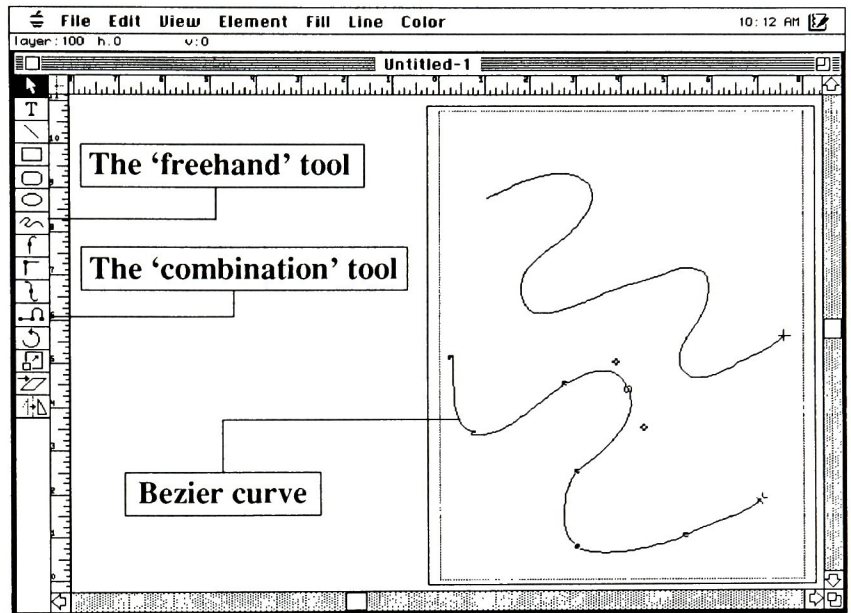
Interpretive matrix	Interpretant	Interpretant	Interpretant
supersign OUTSTANDING MAIL	Postal Service	OVERNIGHT/EXPRESS	MAIL DELIVERY
representation			
iconic	PACKAGE MAIL/STAMP Delivery Truck	STARS/MOON SKY	MOONLIGHT
representation			
indexic	CAP/UNIFORM	WING BARS	SKY AIRPORT/DELIVERY AIRSPACE
representation			
symbolic	MAIL CART STAMP	WING BARS MAIL/STAMP	MAILING CART MAIL/STAMP

Above: An Interpretive Matrix layout sheet helped to systematically list ideas. Below: The rough sketch of the eagle metaphor idea put the concept together.



scanning device—as was used in this investigation—to digitize the sketch, thus creating a bit-mapped computer file. The scanning device used in this investigation was Thunderscan, by Thunderware Inc. The software ran on a Macintosh Plus attached to an ImageWriter II. A scanned image was easier to trace over and could be resized and edited making it far more flexible than the acetate method.

After scanning and saving the sketch, the image was copied to the Macintosh computer clipboard. Aldus FreeHand (version 1.0) was then opened and the clipboard image pasted into the document. The software automatically placed the clipboard image on a special drawing layer—layer 0—reserved for templates (though the image could be moved to other layers). On layer



The FreeHand 1.0 interface window. The drawing tools create bezier curves which have adjustable handles on the data points.

0 all images appear a 50% gray—an easy to trace over value.

Once in Aldus FreeHand there were many drawing tools at the artist's disposal. The tools most useful were the 'freehand' tool, and the 'combination' tool.

Both tools allowed creation of curved or straight-lined polygons by plotting data points—which could be specified as corner, connector, or curve points. FreeHand allowed precise control over curved lines through the use of bezier curve technology.

The 'freehand' tool, as the name implies, allowed a spontaneous line to be traced simply by clicking and dragging the mouse. The drawback was that the line the tool created never quite matched what was initially traced—no matter how carefully done—invariably requiring more editing than expected.

The 'combination' tool, by contrast, was somewhat slower to use but provided exceptional control

and thereby became the favorite here.

As alluded to earlier, FreeHand also possessed a multi-layer control function. This feature, which was somewhat like working with overlays, gave the artist some 200 layers to work on. This allowed complicated drawings to be created by placing various sections on different layers, thus reducing redraw time on the computer screen.

FreeHand's text handling features were also well suited for creating infographics. In contrast, say, to Adobe Illustrator's 256 character limit, FreeHand's text blocks could hold, besides many more lines of text, multiple type fonts and styles. This feature was useful in creating the headline and summary paragraph. The typefaces chosen for the graphic were LB Helvetica Black for headlines and Helvetica and Helvetica Bold for body copy.

The "Join Elements" command,

which allowed text to run along a curvilinear path, was particularly useful for setting the type in the eagle's wing feathers without having to individually rotate each letter as Adobe Illustrator or MacDraw II would have required.

There also was the "Align Elements . . ." command which was tremendously useful. This feature allowed objects to be aligned horizontally and/or vertically according to their centers or their top, bottom, left or right sides. The starfield behind the eagle was easily and precisely accomplished using this alignment feature.

And then there were FreeHand's color capabilities. The program allowed colors to be specified as CMYK (process color) percentages. As process color has been a relatively new development for computer graphics, the procedure merits a somewhat detailed description.

First, to designate that process colors were to be used, one checked

the “include process colors” box under the “New . . .” or “Document setup” commands from the file menu.

After creating an object using the drawing tools, one could add colors by going to the color menu and choosing the “Process color . . .” command. A dialog box then appeared providing scroll bars for each color—cyan, magenta, yellow and black—by which percentages could be chosen. One could also directly type in percentages. One then identified the color by typing a “Color name” and clicking “OK”. And viola! The color was set!

But a note of caution. After creating and arbitrarily naming several colors, it became confusing to remember exactly what those colors were. Therefore it became expedient to devise a way of code-naming colors and the advice here is

Process color

Color name bl 70 50 20 20

Definition

Cyan	<div style="display: flex; align-items: center;"> <div style="width: 10px; height: 10px; border: 1px solid black; margin-right: 5px;"></div> <div style="width: 100px; height: 10px; border: 1px solid black; position: relative;"> <div style="width: 70%; height: 100%; background: repeating-linear-gradient(45deg, transparent, transparent 2px, black 2px, black 4px);"></div> </div> <div style="width: 10px; height: 10px; border: 1px solid black; margin-left: 5px;"></div> </div>	<div style="border: 1px solid black; padding: 2px 10px;">70</div>	%
Magenta	<div style="display: flex; align-items: center;"> <div style="width: 10px; height: 10px; border: 1px solid black; margin-right: 5px;"></div> <div style="width: 100px; height: 10px; border: 1px solid black; position: relative;"> <div style="width: 50%; height: 100%; background: repeating-linear-gradient(-45deg, transparent, transparent 2px, black 2px, black 4px);"></div> </div> <div style="width: 10px; height: 10px; border: 1px solid black; margin-left: 5px;"></div> </div>	<div style="border: 1px solid black; padding: 2px 10px;">50</div>	%
Yellow	<div style="display: flex; align-items: center;"> <div style="width: 10px; height: 10px; border: 1px solid black; margin-right: 5px;"></div> <div style="width: 100px; height: 10px; border: 1px solid black; position: relative;"> <div style="width: 20%; height: 100%; background: radial-gradient(circle, black 1px, transparent 1px); background-size: 4px 4px;"></div> </div> <div style="width: 10px; height: 10px; border: 1px solid black; margin-left: 5px;"></div> </div>	<div style="border: 1px solid black; padding: 2px 10px;">20</div>	%
Black	<div style="display: flex; align-items: center;"> <div style="width: 10px; height: 10px; border: 1px solid black; margin-right: 5px;"></div> <div style="width: 100px; height: 10px; border: 1px solid black; position: relative;"> <div style="width: 20%; height: 100%; background-color: black;"></div> </div> <div style="width: 10px; height: 10px; border: 1px solid black; margin-left: 5px;"></div> </div>	<div style="border: 1px solid black; padding: 2px 10px;">20</div>	%

OK

Cancel

The process color window shows how CMYK percentages were specified and named for this project.

Infographic Studies

that anyone else would be wise to do so as well when specifying colors in FreeHand. The code-names worked like this. The first letters indicated a color's predominant hue:

- r—red
- o—orange
- y—yellow
- gn—green
- bl—blue
- p—purple
- br—brown
- gy—gray
- w—white
- bk—black

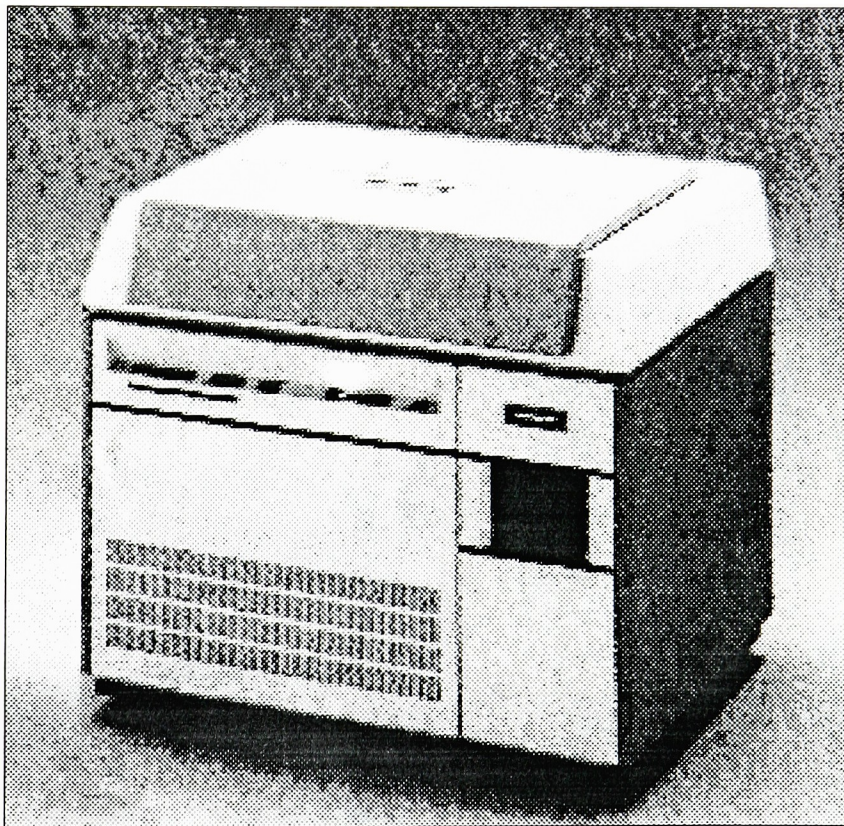
Following the code-letters the corresponding CMYK percentages were entered. The result was that one could know the basic 'hue' of a color, plus the exact percentages simply by looking at the color menu instead of repeatedly opening the dialog box.

The next logical question might be: Why was it so important to know the exact percentages? The answer is: Because all the colors were chosen out of a printed process color guide; not off the computer screen.

For someone working with a

black and white monitor, a process color guide would obviously be the only choice, but what about color monitors as was used here? The answer this time is: The colors on the Mac II monitor simply never matched the actual CMYK colors specified—but the process color guide did match.

Remember that the Macintosh screen displays colors using the RGB color model; an additive color process. The Mac II used here was equipped with a standard video expansion kit allowing some 256 col-



The Linotronic 500 can produce 1690 dpi output resolution.

Infographic Studies

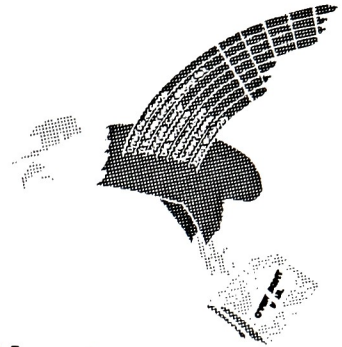
ors to be seen at a time. It quickly became evident that 256 colors do not last long when creating a complex color drawing. But it was also significant to remember that those 256 colors only limited what was seen on the computer screen, not what would appear in inks printed on paper. As Simon Tuckett has observed on this matter:

Do not, for a moment, think that you can match existing real life colors to the colors on the screen. They are wildly different. There are so many variables, including monitor calibration, screen brightness, office lighting and, yes, personal preference. When specifying and matching colors to existing colors, rather than attempt to create the match on screen, use your four-color swatch book.²⁹

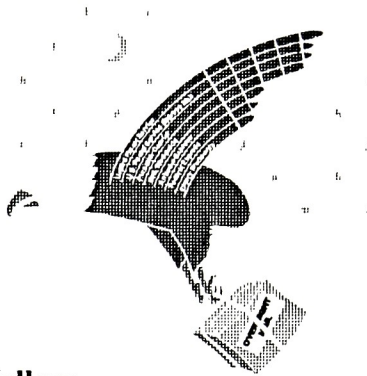
After the infographic reached a stage where it became desirable to see the product on paper, proofs



Cyan

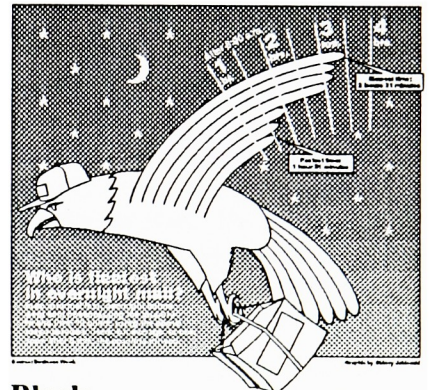


Magenta

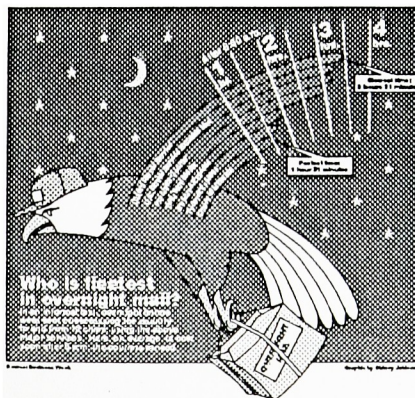


Yellow

Process color separations



Black



Composite

were printed out on a LaserWriter II NT. The LaserWriter's printouts enabled one to test how the graphic would print as color separations as well as a composite image. Several versions of the graphic were printed out before the piece reached its final form. The most obvious limitation, in addition to dpi resolution was the limitation to black and white output. And although there were some color hardcopy printers on the market, none were available at the facilities where this thesis was conducted.

After the infographic reached its finalized form and the computer file was stored on a 3 1/2" microdisk, a Linotronic laser imagesetter was used to process the color separation film negatives.

From these negatives, color keys were made for final presentation. Color keys are clear overlays, one for each process color, which, when stacked on top of each other show the final result. In fact, it was not until color keys were made that one

truly knew how closely the computer generated art would match the color guide.

Critique: chart vs. metaphor:

In addition to the highly illustrative graphic, a plain, straightforward bar chart was created for comparison. The plain chart was given the same typefaces and a similar color scheme as the metaphor chart. As simple and straightforward as the plain chart looks, it still required considerable care and attention to detail to create a clean, harmonious graphic.

The plain chart presents the delivery times consecutively from fastest to slowest. There are no visual distractions. The eye quickly perceives the relationship between the figures with pointer balloons—the only graphic adornments of any kind—emphasizing the most important numbers.

By contrast, the metaphor chart takes the viewer on a visual journey. The eagle—the most dominant

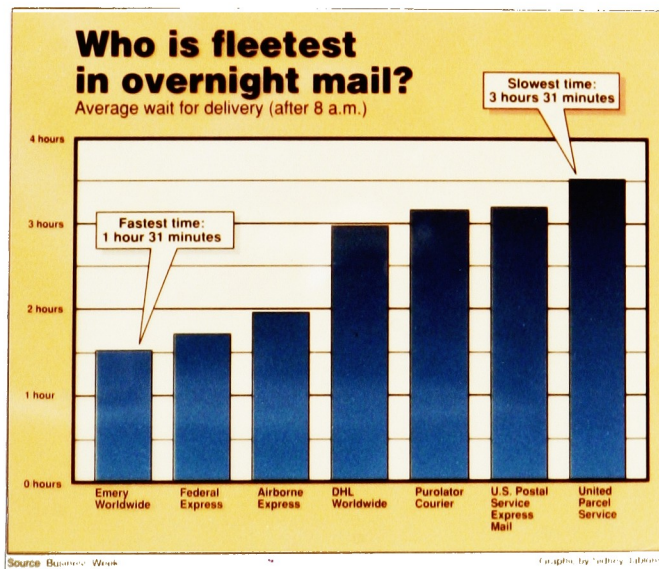
feature—symbolically serves to impress the topic on the viewer's mind.

This effect is reinforced by the cap, the package and the night sky. The summary paragraph serves to invite the viewer to learn not only what, but the who, where and why behind the graphic.

Finally, the wing/bar chart presents the same data as the plain chart but with more dynamic emphasis on the time involved.

Overall, the metaphor chart abstracts itself well into a bar chart. And indeed all the elements catch the eye and hold the attention, thus making a greater impact on the viewer's mind than the plain chart. The eagle's wing, despite its shape, arguably displays the data as well as the plain bar chart. The main concern, however, is that the performance of Emery Worldwide becomes rather lost amid the visual excitement. ■

Infographic Studies



Conventional chart compared to visual metaphor.

Infographic Studies

Study two: Herbal Tea

Subject:

A potential sale of Celestial Seasonings by Kraft to Lipton would give Lipton an 81% share of the herbal tea market. An infographic could depict the implications of such a deal.³⁰

Data:

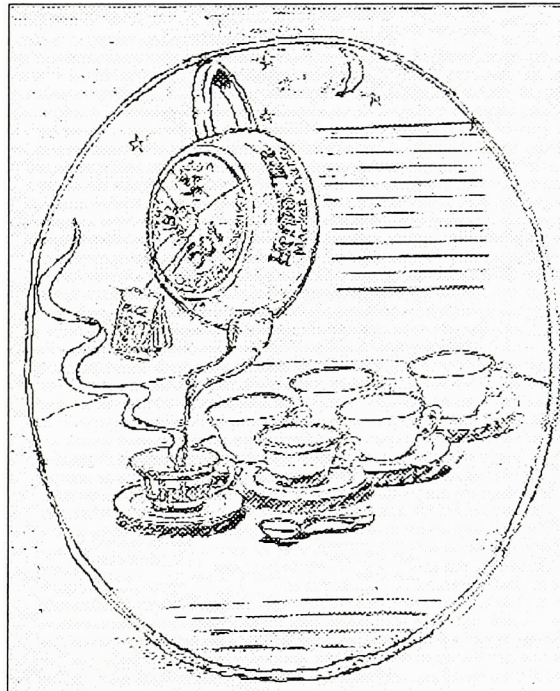
A review of the figures available indicated that a pie chart might do the best job. Pie charts work well when dealing with statistics representing components of some finite whole. The subject here dealt with the respective portions of the herbal tea market controlled by the respective companies.

Concept development:

Developing a pie chart metaphorically was a challenge. The pie

Interpretive matrix	Interpretant	Interpretant	Interpretant
supersign HERBAL TEA	BEVERAGE	MARKET CONDITIONS	COMPANIES
representation			
iconic	TEA BOLD TEA PLUS TEA KISTLE TEA DEAR TEA BANG		LOGO - LIPTON Celestial Seasonings
representation			
indexic	STEAM CLOUD	PIE CHART	
representation			
symbolic	COMPANY NAMES 'CELESTIAL SEASONINGS' 'LIPTON' COMPANY LOGOS	DOLLAR SIGN EMPTY TEA CUPS	STARS - CELESTIAL S. LIPTON TEA CUP Celestial Seasonings

Interpretive matrix (above) and sketch (below).



Infographic Studies

chart format did not easily lend itself to variation. Most attempts to alter the elliptical shape tended to make the chart visually ineffective.

In response to this, an elliptical motif was developed and repeated throughout the sketch in such things as the tea kettle, cups and border.

The pie chart itself became the lid of the tea kettle; meanwhile symbolic relationships and elements were incorporated elsewhere in the image.

The stars in the sky allude to Celestial Seasonings corporate theme whereas the five empty Lipton tea cups represent the 50% market share Lipton could acquire by purchasing Celestial Seasonings. Other symbolic elements included to complete the mise-en-scène were tea leaves, tea bags and a tea spoon. Meanwhile, the dropletter "C" and the elliptical border were made to mimic

Celestial Seasonings' packaging.
Revision and processing:

The procedure followed basically the same pattern as for the "Overnight Mail" graphic, except for one detail. To create a pie chart in

properly proportioned 'slices,' the program Microsoft Chart was used. By typing in the various percentages, it was possible to create a simple pie chart. This image was then copied to the clipboard and



An early version of Herbal Tea infographic with headline in foreground.

Infographic Studies

pasted into FreeHand for use as a template.

As the infographic neared completion, it went through several modifications. First, the dropletter "C" originally had a diamond shaped backdrop behind it which was later changed to tea leaves.

Meanwhile, the copy in the 'sky' and foreground were switched and edited in order to place the headline at the top of the graphic. This change allowed the graphic to read in a more conventional style.

The tea kettle was also enlarged and shifted to create a 'break-out' over the border. The purpose of this revision was to interrupt the overbearing rigidity of the border's elliptical shape.

Because of the computer's editing capabilities, such modifications were fast and easy.

Critique:

A plain pie chart was made showing the current market shares of the herbal tea market. The plain chart, even with a 3-D treatment against a colored background, main-

tains an austere look. The presentation is clean and direct though it fails to visually impart any information about future or past market conditions.

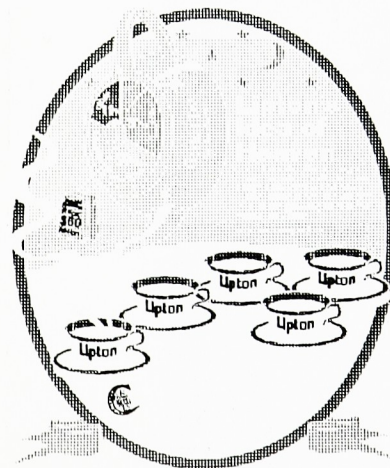
The metaphor infographic,



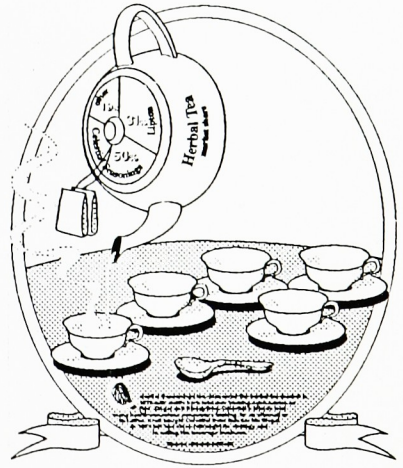
Cyan



Magenta



Yellow
Process color separations



Black

Infographic Studies

meanwhile, could almost be a stand-alone piece. Unlike the plain chart, the pie chart in the metaphor graphic is not the center of attention, but just one element helping to convey the bigger story. ■



Conventional chart compared to visual metaphor.

Infographic Studies

Study three: Flying Tiger

Subject:


The fortunes of the air freight carrier Flying Tiger have changed for the better. After years of heavy losses the company, aided by deregulation, has become profitable again. An infographic would need to be able to show the turnaround.³¹

Data:

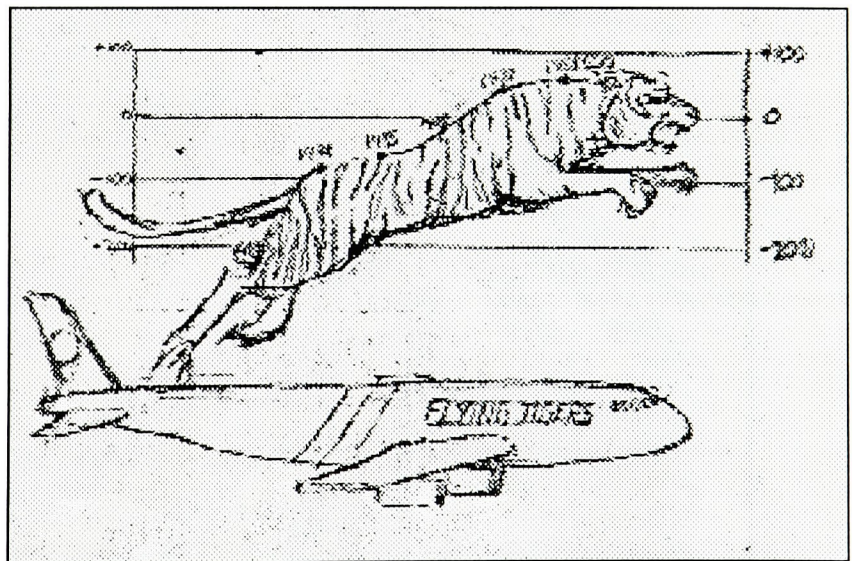
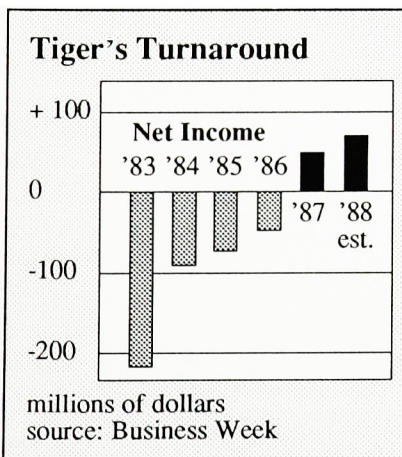
The figures available for this were already in the form of a simple bar chart (see example lower left) showing a year-by-year comparison from 1983 and estimated through 1988. For this type of data a bar chart or fever chart/line graph could work equally well.

Concept development:

Since the data lent itself equally well to bar chart and line graph formats, both were considered. It was decided to try to incorporate tiger 'scratch marks' into the

Interpretive matrix	Interpretant	interpretant	interpretant
supersign	AIRFREIGHT CO.	TIGER IMAGE	
representation	<ul style="list-style-type: none"> •AIRWAYS •PASSENGERS •LET PLANE •CARRY TONES 	TIGER 	
representation	<ul style="list-style-type: none"> •TERRITORY •TIGER PAWL 	TIGER CARRYABLE STAGES ORANGE & BLACK	
representation	RED & BLACK TIGER	STRIPES ORANGE & BLACK	

Interpretive Matrix (above) and an early sketch (below). This sketch shows how the statistical data could have been composed as a line graph.



Infographic Studies

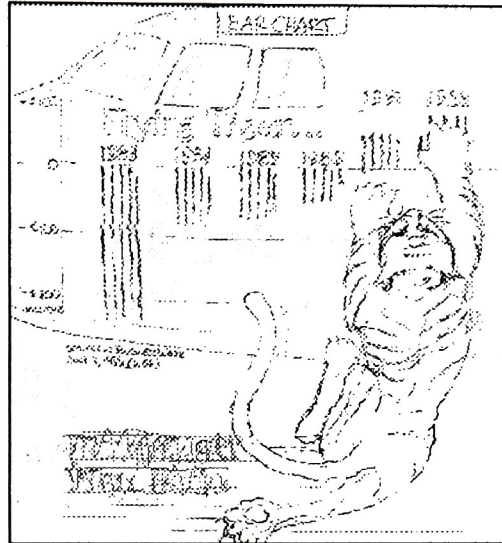
graphic. And because the scratch marks worked well as bars, the bar chart format won out.

A problem, however, was trying to find a harmonious way to bring together a tiger image and an airplane image. Both were crucial symbolic elements, but just didn't seem to work together. After several attempts, finally a version emerged featuring a tiger on a runway with an airplane looming in the background.

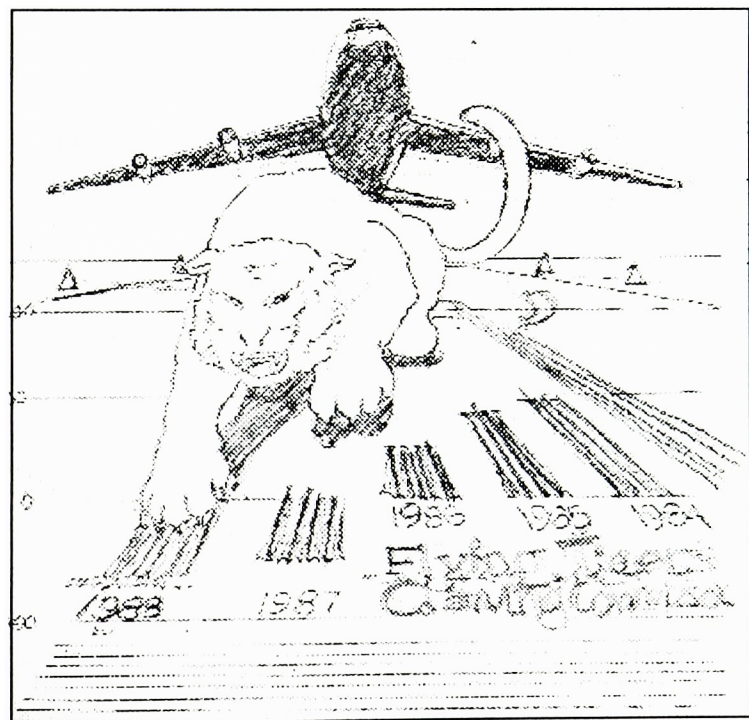
Critique:

As in the earlier "Overnight Mail" study, the plain bar chart is direct and to the point. But the disadvantages here are:

- The exact amounts were not



Two sketches composing the data in a bar chart format.



available from the source, so pointer balloons emphasizing significant figures could not be used.

- The data involves negative and positive values. When positive and negative values are shown in a conventional bar chart, though the function is performed adequately, the chart is often left visually unbalanced as is here.

The metaphor chart, on the other hand, presents a different set of considerations. Graphically, the image is quite dynamic. Extreme foreshortening and the head-on poses of the airplane and tiger literally thrust out toward the viewer. And the inverted handling of the bar chart's 'tiger scratches' causes them to march toward the foreground too.

All this forward movement is subtly balanced by the 'backwardly' falling shadows behind the tiger, numbers, and letters. It is worthy to point out that the negative data is

appropriately labeled by red figures; correspondingly the positive data is labeled by black figures.

Meanwhile, placing the headline and subheadline at the bottom arrests the eye from wandering off the page.

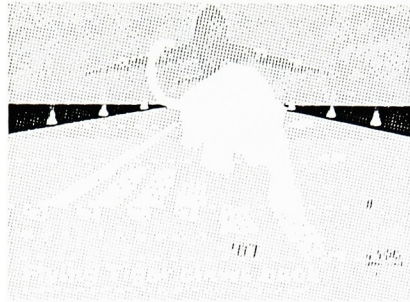
Of legitimate concern, moreover, is the perspective handling of the bar chart. To protect the integrity of the chart data, distortion of scale is commonly frowned upon. Even Nigel Holmes has warned:

the artist must be responsible when it comes to designing, and not deliberately try to mislead . . . Too often, in an effort to dress up a chart with illustration, an artist loses focus of the work, and the resulting art obscures the meaning of the figures, rather than helping a reader understand them. The chart may have engaged the eye, but if the information is not accurately portrayed, the artist has

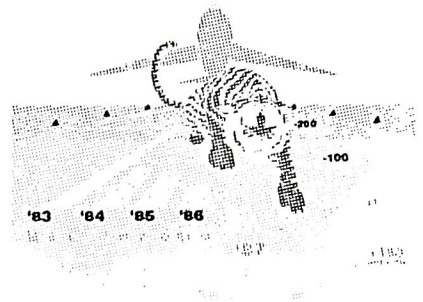
wasted his or her time as well as the reader's. In the long run charts will be ignored if they cannot be trusted. And they will be mistrusted if too many of them are biased, or erroneous, or too exaggerated.³²

In this graphic, though, to maintain a truly accurate scale would have appeared visually distorted. Thus it became necessary, that in order to present the true relationships between the figures to the viewer, a perspective scale was essential. Also, since no exact figures were attained from the source, (or needed to convey the message), all that had to be preserved were proportional relationships between the numbers. ■

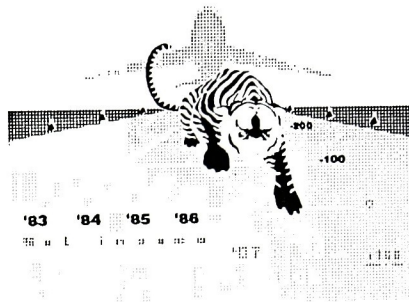
Infographic Studies



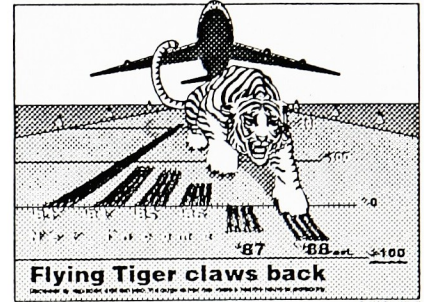
Cyan



Magenta



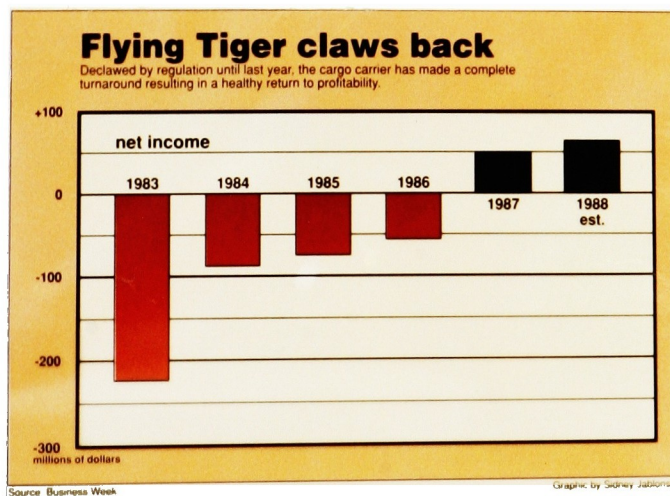
Yellow
Process color separations



Black



Composite



Conventional chart compared to visual metaphor.

Infographic Studies

Study four: Asian Students

Subject:

The U. S. Department of Education's latest figures reveal a steady increase in Asian student enrollment in United States colleges. In the ten year period from 1976 to 1986 the Asian student enrollment has more than doubled.³³

Data:

From the data (below left) one could once again easily choose between a bar chart or line graph representation. However, because the figures deal with showing a flow occurring over a period of time, the line graph was chosen. The line graph excels because it can show trends as well as accurately enumerate given quantities of data.

Concept development:

Initially, a linear form was sought with which to merge the line

graph. The immediate thought was to use an oriental dragon and have the back and tail become the chart line. Composing and filling out the rest of the concept, however, involved many revisions. A school pennant was replaced by a desk lamp, eyeglasses were added and the rendering of the dragon altered several times.

Revision and processing:

The revision process continued on into the computer stage. The dragon changed from a serpentine form to a beast with legs. The spines on the dragon's back were made smaller to become less distracting and the tail was repositioned. When the eyes were changed and glasses added, the dragon became less 'sinister' and more 'student-like.' Meanwhile, the school pennant which was replaced by a desk lamp improved

the composition lines by directing the eye back into the graphic.

Originally the headline was located in the lower right hand side of the graphic, but that arrangement directed the eye away from the information and seemed to focus attention to the already conspicuous dragon. When the text was repositioned in the upper left, the graphic achieved a balance which had been previously lacking.

Critique:



As expected, the plain line graph performs its function with elegant efficiency. The pointer balloons flag the reader's attention and declare clearly the figures of greatest importance. Overall, the absence of auxiliary elements harks back to the Vienna Method of Otto Von Neurath and pure functionality.

By contrast, the dragon domi-

Asian Enrollment

1976	198,000
1978	235,000
1980	286,000
1982	351,000
1984	390,000
1986	448,000

Source: The Chronicle of Higher Education Almanac

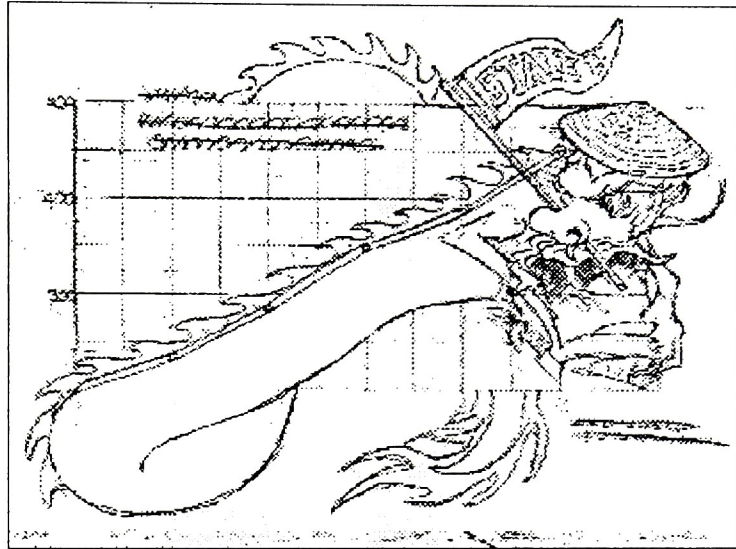
Interpretive matrix	Interpretant	Interpretant	Interpretant
supersign ASIAN STUDENTS	ASIAN CULTURE	COLLEGE	
representation iconic	Karaoke Chop sticks	Books Jug League Buildings Columns	
representation indexic	Hat	Calculator Eye Glasses Desk Lamp Test-tube	
representation symbolic	Buddist Shrine Dragon Scroll Flag Oriental robe-form Beijing Sun	School Restaurant School Ducks Marbleboard Shampoo	

nates the metaphor graphic. The careful placement of the text in the upper left, the reversed typeface and the strong blue of the line graph secure distinction for the data.

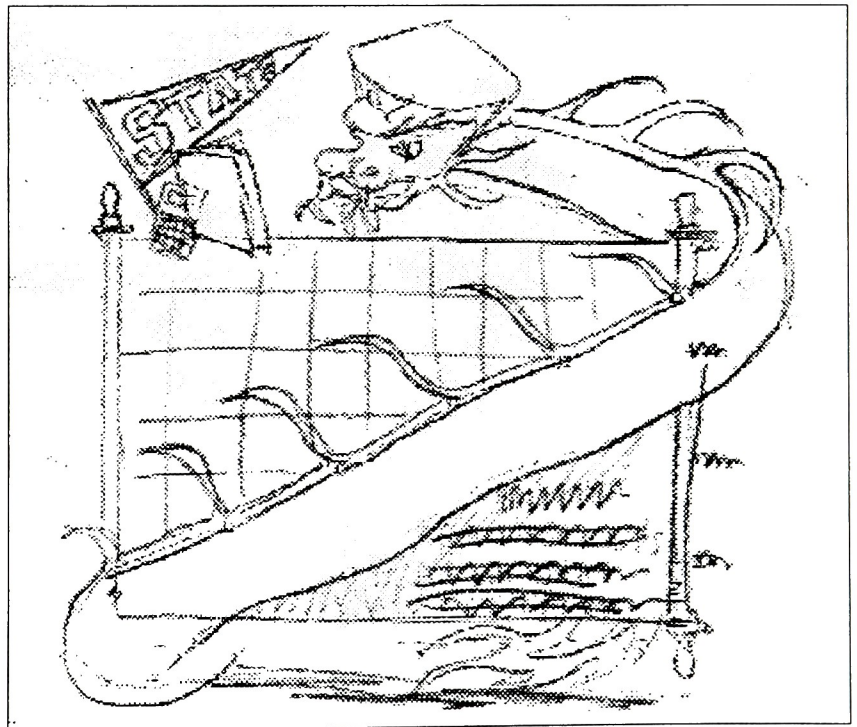
The spines on the dragon's back also draw attention, but, due to their locations, they do serve to highlight the figures.

Also, the dotted line extensions of the graph lines 'flatten' and diminish the overbearing impact of the dragon form. This allows the text to secure its proper degree of prominence.

As expected, the metaphor graphic relays the subject before a single word needs to be read. A point of criticism, though, could be

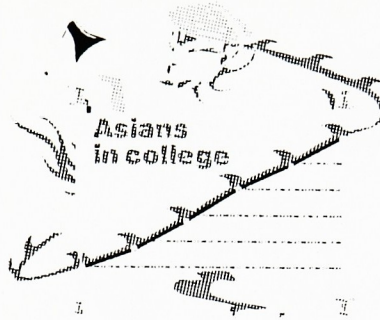


Early sketch (above) and later sketch (below).

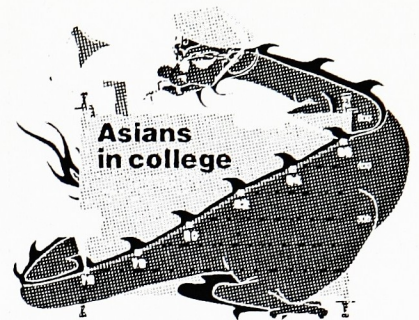


Infographic Studies

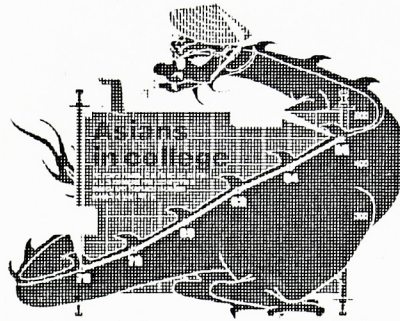
the swirling composition which tends to sweep the eye along without giving it time to stop and absorb the data. The redeeming factor here, though, is that the composition lines keep flowing back to the beginning; sort of an endless loop bringing the eye back for more information. ■



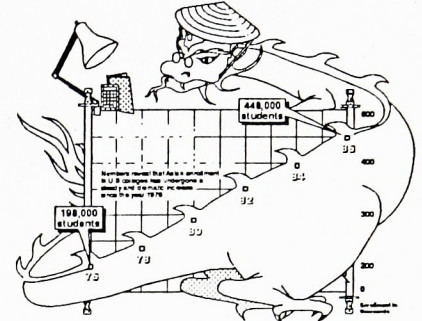
Cyan



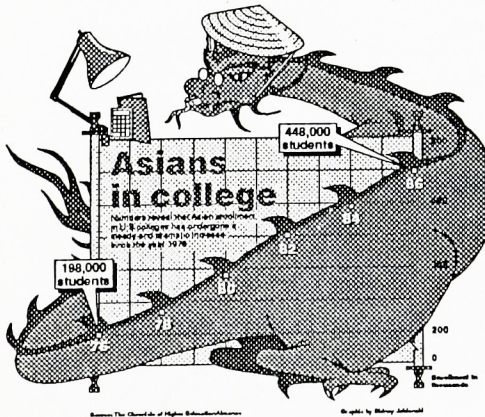
Magenta



Yellow
Process color separations

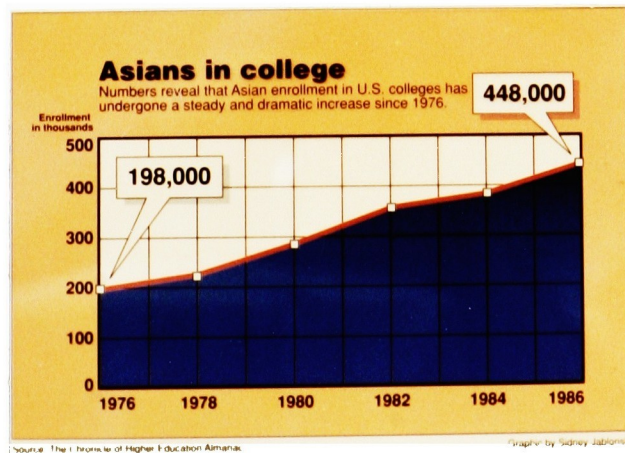
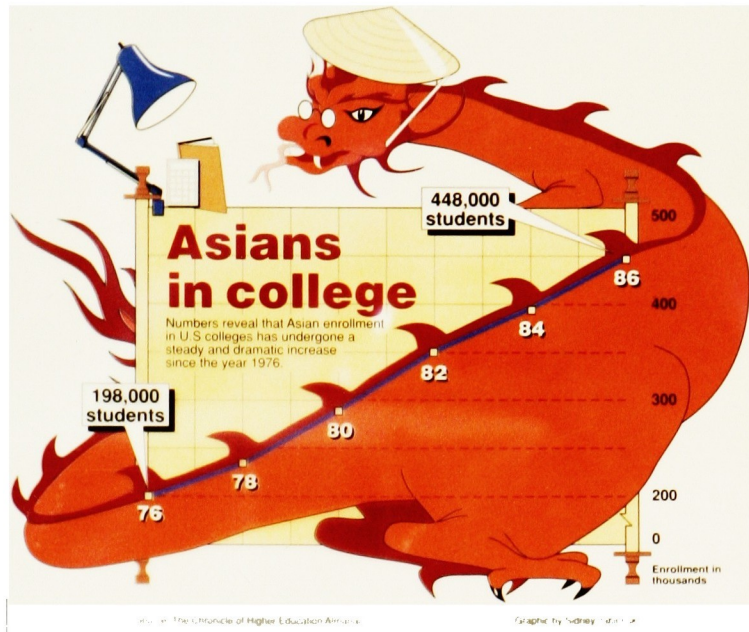


Black



Composite

Infographic Studies



Conventional graph compared to visual metaphor.

Infographic Studies

Study five: Aluminum Bats

Subject:

James Easton has built a small arrow-shaft company into the major producer of aluminum bats. Only major-league baseball has not adopted his company's product.³⁴

Data:

The source stated that Easton controlled 95% of the market. This could have been shown as a pie chart but another approach was experimented with instead. It was decided to present the market share figures as sort of a stacked bar chart comprising a baseball bat, which, hopefully would be more readable.

Concept development:

The concept was to create a baseball player holding a bat/bar

interpretive matrix	interpretant	interpretant	interpretant
supersign aluminum bats	Baseball	League	
representation			
iconic	Home State CAF (University) Winnipeg Vancouver East Coast	Gold-Silver-Bronze Olympic medals	
representation			
indexic	Capitulum Stadium Olympic Stadium	State College Japanese Flag Cuban Flag Mexican Flag	
representation			
symbolic	James Easton Summer	Gold-Silver-Bronze Major League	

Interpretive Matrix (above) and rough sketch (below).

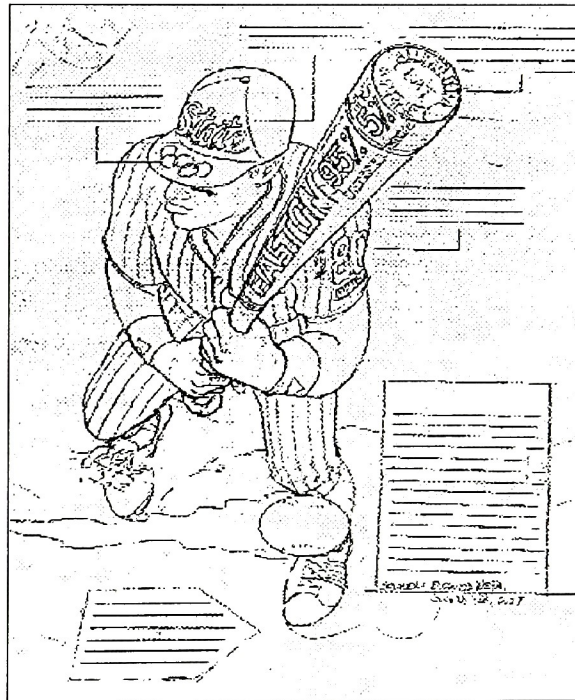


chart. The bat would serve as a stacked bar chart but be strongly three-dimensional rather than abstractly two-dimensional. Also, the player's uniform was to have symbolic elements (such as the Olympic logo) which would help tell the story. A dramatic angle was chosen to draw the eye into the graphic.

Revision and processing:

Several arrangements of the text were tried. Initially the idea was to configure the text as small descriptive paragraphs connected by pointer arrows to symbolic elements in the illustration. Such an arrangement proved visually unwieldy though, and in the end the text was arranged in a column along the left side.

Technically, this piece encountered some processing problems when sent to the Linotronic 500. The file, when sent to the Linotronic was generating a PostScript error. Such a development was not anticipated

since the image had processed without incident on a LaserWriter.

Here is what happened. The 'on-deck circle' was composed of a radial fill pasted inside an ellipse. This ellipse, along with the player's shadow was then pasted inside the large background rectangle. The result was, in PostScript jargon, a limitcheck error which occurred while a clip command was being executed. In english, this means that there were evidently too many polygon sides for the available memory of the Linotronic; a situation which arose by overdoing the 'paste inside' function. The suspected culprit in this case was the 'shadow' polygon.

To correct this problem the image was brought into FreeHand version 2.0 (recently released) which had more tools.

First, all the 'paste inside' procedures were undone. Next, the 'on-deck circle' was remade. In FreeHand 2.0 a blend function was

used to replace the radial fill in the ellipse. The blend function generated a shaded effect by creating a sequence of shapes laid on top one another. The shadow was not changed.

The new 'on-deck circle' and the shadow were then simply masked off by a white rectangle placed on top of them. A black line-segment also had to be added to rebuild the border blotted out by the white rectangle. This solution, however simplistic, did alleviate the PostScript error and allow the image to process smoothly.

Critique:

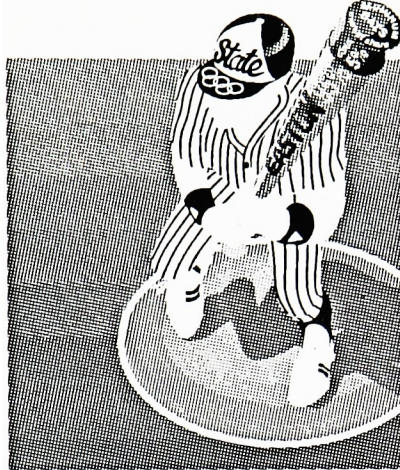
This infographic differs from the previous studies in that the data would not really have merited a traditional chart or graph. That is, Easton's 95% market share data would have produced an extremely awkward pie chart or bar chart because the data was so lopsided. Also, the source failed to list any specific information on other

Infographic Studies

companies.

Compositionally, the baseball player is the dominant element, arresting the attention and directing the eye back toward the text.

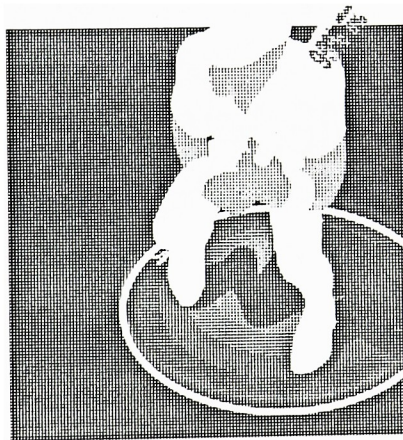
The bat—the topic of the infographic—is the sole item with any metaphoric function; serving as a stacked bar chart. However, the bat does not dominate or overwhelm the composition. Rather, it serves as a point of entry, strongly drawing the eye into the work. This is both the strength and the weakness of this piece. A little more abstraction could have given the bat a more chartlike look but it also might have negated the dramatic harmony that now exists. ■



Cyan



Magenta



Yellow
Process color separations

Easton: Aluminum Bat Champion

League leader

Easton Aluminum Inc., located in Van Nuys, California, is a privately held company, headed by 62-year-old president James L. Easton. The company controls 90% of the \$65 million a year aluminum bat market.

Amateur and college teams

Easton bats, besides dominating professional softball games, are used extensively by virtually every U.S. college team.

Olympic performer

Easton aluminum bats were used by most of the baseball teams competing in the 1988 summer Olympic games in Seoul, South Korea.

Major-league strike-out

All the professional baseball leagues use wooden bats. The pro contour that metal bats have the last two years and might even be dangerous.

Source: Business Week



Black



Completed infographic.

Conclusion

The modern infographic owes much to the early efforts of William Playfair and Dr. Otto Neurath. Indeed the austere, purely functional methods of Neurath are still common today. But the contemporary popularization of metaphorical handlings of charts and graphs must be credited to Nigel Holmes.

Meanwhile, newspapers have become patrons of infographics and, by incorporating the Macintosh as an artist's tool, have promoted modern production methods.

I myself have found that to create infographics using computers, I have had to become an eclectic blend; part journalist, part illustrator, part graphic designer and part computer hacker.

The infographic, in the hands of a skilled artist, can become, not just a report of facts, but an editorial piece (if desired) with the ability to sway and alter opinions. As Holmes has observed on the matter:

The infographic steps in, by translating numbers into an image that is informative, meaningful, and above all, memorable.

35

As the aim of this investigation was to explore a given conceptual approach and production method, it has not tried to address all possible alternatives. Admittedly, not all chart forms and formats were discussed. But hopefully this account has succeeded in identifying and articulating on the salient developments and directions in the growing specialization of infographics.

I can happily say that from this work I have become considerably more conversant in visualizing statistical data and in harnessing the computer's power as a graphics tool. Furthermore, I confidently feel that the knowledge I have gained from this project will continue to influence my future artistic endeavors. ■

Endnotes

1. Holmes, Nigel, Designer's Guide to Creating Charts and Graphs, (New York: Watson-Guptill Publications, 1984), p. 12.
2. Holmes, Designer's Guide, p. 12.
3. Holmes, Designer's Guide, p. 12.
4. Holmes, Designer's Guide, p. 13.
5. Holmes, Designer's Guide, p. 13-14.
6. Holmes, Designer's Guide, p. 16.
7. Holmes, Designer's Guide, p. 18.
8. Holmes, Designer's Guide, p. 13.
9. Holmes, Designer's Guide, p. 21.
10. Holmes, Designer's Guide, p. 21.
11. Tschichold, Jan, "Statistics in Pictures," Commercial Art, vol. 11, 1931, p. 114.
12. Holmes, Designer's Guide, p. 21.
13. Holmes, Designer's Guide, p. 21.
14. Holmes, Designer's Guide, p. 9.
15. Garneau, George, "Infographics: Editors believe the use of news graphics will continue to grow," Editor & Publisher, 22 October, 1988, p. 44.
16. Leeke, Jim, "Mac graphics make daily news," MacWEEK, 28 February, 1989, p. 34.
17. Leeke, p. 34.
18. Leeke, p. 34.
19. Leeke, p. 34.
20. Silverstone, Stuart, "Newsroom Graphics," Macworld, February 1987, p. 31.
21. Leeke, p. 36.

Endnotes

22. Leeke, p. 36.
23. Roth, Steve, "Selecting a Color Separator," Macworld, March 1989, p. 132.
24. Southworth, Miles, Pocket Guide to Color Reproduction Communication & Control, (Livonia, New York: Graphic Arts Publishing Company, 1979) pp. 2-7.
25. Roth, "Color Separator," p. 132.
26. Woolley, Suzanne, "Overnight Mail: Who Delivers," Business Week, 6 June, 1988, p. 143.
27. Holmes, Designer's Guide, p. 24.
28. Okerse, Thomas, "De-Sign/Super-Sign," Semiotica, 52-3/4, 1984, p. 271.
29. Tuckett, Simon, "Object-Oriented Color on the Mac," Step-by-Step Graphics, January, 1989, p. 77.
30. Atchison, Sandra D., "An Herbal Tea Party Gets a Bitter Response," Business Week, 6 June, 1988, p. 143.
31. Toy, Stewart and Christopher Power, "Flying Tiger: Roaring, Soaring—and Prowling for Planes," Business Week, 4 July, 1988, pp. 56-60.
32. Holmes, Designer's Guide, p. 166.
33. "National Snapshot: Racial and Ethnic Enrollments and Degrees," The Chronicle of Higher Education Almanac, 1 September, 1988, p. 81.
34. Grover, Ronald, "James Easton: Putting a 'Ping' in Baseball's Swing," Business Week, 13 June, 1988, p. 57.
35. Holmes, Nigel, "Time's graphics director helps you Get Smart About Charts," Publish!, March, 1989, p. 42.

Bibliography

- Atchison, Sandra D. "An Herbal Tea Party Gets a Bitter Response." Business Week, 6 June, 1988, p. 143.
- Garneau, George. "Infographics: Editors believe the use of news graphics will continue to grow." Editor & Publisher, 22 October, 1988, p. 44.
- Grover, Ronald. "James Easton: Putting a 'Ping' in Baseball's Swing." Business Week, 13 June, 1988, p. 57.
- Holmes, Nigel. Designer's Guide to Creating Charts and Graphs, New York: Watson-Guptill Publications, 1984.
- Holmes, Nigel. "Time's graphics director helps you Get Smart About Charts." Publish!, March, 1989, pp. 42-45.
- Leeke, Jim. "Mac graphics make daily news." MacWEEK, 28 February, 1989, pp. 34-38.
- Lu, Cary. The Apple Macintosh Handbook, third edition, Redmond, Washington: Microsoft Press, 1988.
- "National Snapshot: Racial and Ethnic Enrollments and Degrees." The Chronicle of Higher Education Almanac, 1 September, 1988, p. 81.
- Okerse, Thomas. "De-Sign/Super-Sign," Semiotica, 52-3/4, 1984, pp. 247-272.
- Roth, Steve. "Color Separation Explained." Macworld, February, 1989, pp. 198-205.
- Roth, Steve. "Selecting a Color Separator." Macworld, March, 1989, pp. 128-137.
- Silverstone, Stuart. "Newsroom Graphics." Macworld, February, 1987, pp. 130-134.
- Southworth, Miles. Pocket Guide to Color Reproduction Communication and Control, Livonia, New York: Graphic Arts Publishing Company, 1979.

Bibliography

- Toy, Stewart and Christopher Power. "Flying Tiger: Roaring, Soaring—and Prowling for Planes." Business Week, 4 July, 1988, pp. 56-60.
- Tschichold, Jan. "Statistics in Pictures." Commercial Art, vol. 11, London: The Studio Ltd., 1931.
- Tuckett, Simon. "Object-Oriented Color on the Mac." Step-by-Step Graphics, January, 1989. pp. 74-82.
- Woolley, Suzanne. "Overnight Mail: Who Delivers." Business Week, 6 June, 1988, p. 143.

Acknowledgements

The energies of researching, executing and writing this thesis project and report were not completely mine alone. A number of individuals contributed to, and generously supported my efforts in bringing this project to fruition. At this time I wish to express my appreciation to:

Robert Keough, chief advisor of my thesis committee, who gratuitously contributed ideas and materials which were instrumental in shaping the development of this investigation.

Jim Ver Hague, thesis committee advisor, for both his technical support and his always seeming to be around when I needed some feedback on ideas and procedures.

Jack Slutzky, thesis committee advisor, for his frank and honest criticisms which urged me to work toward higher aesthetic goals.

Those at *The Orange County Register*:

Bill Dunn, graphics editor, who generously made it possible for me to use *The Register's* Linotronic 500 for the final output of film negatives and color-keys.

Kevin Boyd, Macintosh graphics specialist, who actually pushed the buttons at *The Register* which got the job done on time in spite of the technical difficulties which arose.