INSTRUCTIONAL MATERIALS AND INFORMATION DESIGN

by Michael Babwahsingh

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Abstract

This project focuses on how the design of instructional materials affects a person's learning and understanding, with respect to operation and assembly instructions (mechanical information), maps (spatial information), and conceptualizations of abstract ideas and phenomena (cognitive information). By examining the thought process behind visual information processing, I will illustrate the framework in which visual perceptions become understood and remembered. I will also study how the qualities and organization of graphic design elements, such as lines, shapes, symbols, colors, and text, affect learning and comprehension as well as investigate the psychological aspects of instructional materials. The goal of my research is to identify key steps in the thought process behind effective design based on the visual learning process, graphic design principles, and human needs. I will apply the thought process in one redesign from each category of instructional information.

Introduction

People depend heavily on information in its many forms yet are often left helpless by the sheer magnitude and disorganization of information sources. The amount of information swells every day, providing more "knowledge," new "answers," better "solutions," preying on the insecurities—and wallets—of the masses. According to Peter Large, author of *The Micro Revolution Revisited*, "More new information has been produced in the last 30 years than in the previous 5,000. About 1,000 books are published internationally every day, and the total of all printed knowledge doubles every eight years."[1] Periodicals are cluttered with obscure data, loud graphics, and technical jargon. Educational reference books, such as scientific and mathematical textbooks are wrapped in friendly, attractive covers that falsely represent the pages within, which are often dense with indecipherable facts and figures. Heavy graphic elements and complex symbolic languages in many maps and guidebooks tend to distort geography rather than depict it accurately.

[1] qtd. in *Information Anxiety* 35

The inability to visually communicate ideas has reached a point where illusions of meaning and substance prevail over genuine understanding. The impact of such disinformation on learning is widespread, as demonstrated by the overwhelming difficulty many individuals experience when using unclear instructional materials. Obstacles such as disorganization, inaccuracy, and overdesign prevent one from gathering the necessary information to complete a task and achieve a desired goal.

Information design deals with bridging the gap between the human thought and behavior and the external realm of data and physical reality. Centered on fundamental design principles yet equally rooted in logic and reasoning, information design is a hybrid profession encompassing a range of intellectual, artistic, scientific, mathematical, psychological, semantic, and other specialized skills. Paul Mijksenaar, a Dutch information designer, identifies the influence of "new visual forms borrowed from photography, film, and not least from comic strips and technical illustrations" on information design.[2] These media enhance a designer's sensitivity to the thematic correspondence of ideas.

[2] *Visual Function* 49

Information design is characterized by creative and analytical visualization and the articulation of the underlying structure of facts and data into concise, accessible information. Interpretation, evaluation, and organization are the integral steps in the thought process by which an information designer creates instructional materials.

While the variety of human activities involving instructional information is countless, many fall under three general categories which comprise the focus of this study:

mechanical: assembly instructions and reference manuals (information pertaining to the construction, operation, and function of objects and machinery)

spatial: maps (directions and navigational information)

cognitive: charts and diagrams (visual representations of abstract concepts and data involving science, mathematics, and language)

I will analyze the methods of creating these three types of instructional materials specifically in terms of operating and assembly instructions, subway train maps, and scientific illustrations. Part of my analysis will explore the perceptual and intellectual dimensions of visual information as applied to the learning process. Based on my research of literature on information design and related topics, I will propose a set of general approaches for the effective design of information. Also, I will apply these approaches to the redesign of one ineffective piece from each category.

The designed component of this project is integral to illustrate how information design principles operate. The proof of the criteria lies in their performance; instructional materials incorporating the ideals of visual communication require interaction for one to realize their usefulness.

A key aspect of information design which I will discuss is the psychological relationship between the reader and the instructions. One's attitude toward a task or concept is influenced by the quality of the instructional materials one must use; the extent to which an information designer addresses the spectrum of a reader's needs has a considerable impact on whether an individual interacts with instructional materials and achieves a goal or becomes frustrated and abandons a task altogether.

My study will center primarily on Western (American and European) design perspectives, as the majority of research and available material on information design and related topics is based in Western thought. This is not to exclude literature and materials on non-Western design practices solely

on the grounds of scarcity; an attempt to study the diverse design methods employed by various non-Western cultures, particularly Asian, would prove far too complex a task for the scope of this paper. Dissimilarities among cultural norms and standards, as well as linguistic differences, disallow a global evaluation of design methods or the institution of a universal benchmark for "appropriate" design, even though symbol-based systems for world-wide communication are presently in use in airports, museums, and other public places.

In addition, I have chosen to limit my discussion of charts, graphs, and other quantitative information displays since this subject has been widely explored in recent years. I have, however, incorporated design principles involved in making quantitative information displays.

1 From Perception to Memory

To understand how individuals interact with instructional materials, it is necessary to examine the operations involved in the processing of visual information. According to Werner Severin and James Tankard, Jr., information must pass through four "rings of defenses": "selective exposure, selective attention, selective perception, and selective retention."[1] The signs and signals embedded in a given message are subject to the frequency of contact the viewer has with the material, the level of interest or relevance of the material to the viewer, the specific elements the viewer absorbs or registers, and the amount of information the viewer recalls after initial contact with the material. With the exclusion of selective exposure (a consequence of environment or circumstance), issues of selective perception, selective attention, and selective retention appear under the respective headings of perception, learning and understanding, and remembering.

[1] qtd. in *Information Anxiety* 246-247

Perception: Gathering Clues

For an idea to be communicated, it must take some form capable of being perceived by sensory means—either individually (by sight, hearing, touch, smell, or taste) or in combination. Abstract mathematical and scientific concepts can assume visual manifestations to facilitate cogitation. Visual information, conveyed by shape, color, and figure-ground relationship (occupied space versus empty space), resides in one, two, and three dimensions of space.[2] Jacques Bertin, in his book entitled *Graphics and Graphic Information Processing*, lists eight characteristics of visual information, grouped under two categories:

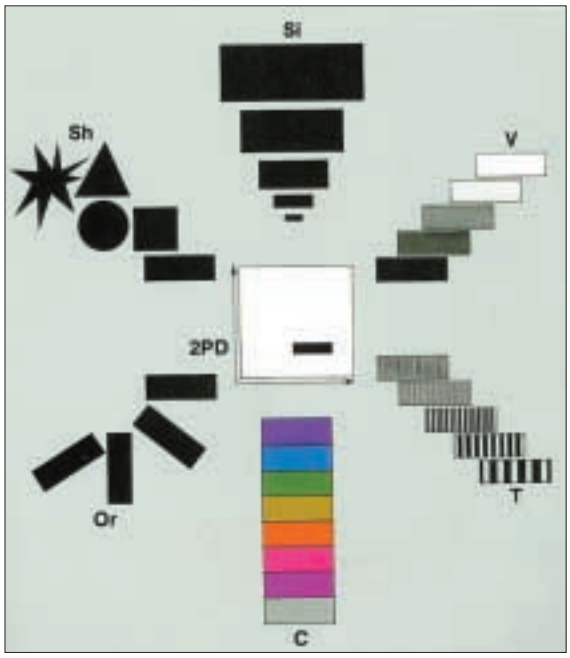
[2] *Information Anxiety* 47

Variables of the Image: width, height, size, and value
Differential Variables: texture, color, orientation, shape[3]

[3] p. 186-187

The variables of the image refer to those aspects of an image one generally perceives first, and the differential variables are more specific identifying features of an image. Although Bertin does not include

typography as it deals more with textual information, the appearance of words on a page does influence visual perception and is therefore included in this study.



Jacques Bertin's illustration of the "visual variables" shows examples of each variable extending from a miniature version of the coordinate plane of space (center) on which they are arranged. "2PD" refers to the two planar dimensions: height and width.

Clockwise from top: size, value, texture, color, orientation, shape.

(*Semiology of Graphics* 42-43)

Specifically in terms of printed materials, Paul Mijksenaar's adaptation of Jacques Bertin's visual variables groups visual perceptions into three categories:

distinguishing variables	immediate perceptions of color, size, images, and type
hierarchical variables	layout, sequence, and type size and weight
supporting variables	variations of color value and intensity, type style, and other "accentuating and emphasizing" elements[4]

[4] *Visual Function* 38-39

The range of perceptions governed by this system is restricted to the realm of the printed page; Bertin points out that the sense of time and motion are not represented by the visual variables (unless arranged in such a way that differences in temporal and spatial proximity appear in sequence). Also, luminosity and surface texture remain largely outside the bounds of two-dimensional space yet the visual variables can illustrate the *illusion* of such perceptions. However, photographs optimally communicate visual information as they directly depict dimensional reality, resulting in instant recognizability.

All visual perceptions are governed by associations. Without clear correspondences between different types of perceptions, what one sees carries no more meaning than simply an assertion that a percept exists; a color is simply a datum unless it is associated with a name (at the most basic level), and with a logical or emotional meaning derived from an initial perceptual experience.

Perception is not defined by universal standards. Like verbal language, it is representative of a spectrum of experiential constructs particular to different sociocultural environments. Perception is highly subjective, an act that is dependent on both the viewer's knowledge and on external triggers; it "implies perceptivity, insight, and intuition—the ability to make meaningful observations about events and ideas, to relate one set of images to another."[5] Symbolic languages operate on basic assumptions about an audience's experience with pictographic representations; those that bear close resemblance to physical realities, such as shapes of objects and people, are normally more recognizable than symbols communicating non-visual sensations and abstractions, such as heat and danger. Since the level of their abstraction and context greatly affects perception, symbols are not accessible to the widest audience; however, supplementary text can clarify meaning.

[5] *Information Anxiety* 256

Increased abstraction of symbols obscures meaning as identifying details of an idea or object are minimized. These symbols, designed by C. K. Bliss as part of an auxiliary picture language, represent water, fire, and man (left to right). The relationship between the original concept and its representation is very difficult to understand because of the oversimplified figures.

("Graphic Symbols" 109)

The symbols above stand for food, telephone, and stop. While common in many cultures, symbols such as these are unreliable for global communication because of the diversity of interpretations possible.

Crossed eating utensils may resemble an "X" rather than suggest a place to eat. The telephone handset may look like a detached handle since the phone cord and unit are missing. The exclamation mark inside the hand may not mean "stop" to one who is unfamiliar with the mark's meaning.

The first two symbols are from the International Union of Railways and the third is by Paul Arthur & Associates, Ltd. for the 1967 World Exhibition.

("Graphic Symbols" 108, 125)

Conventions in American culture build one's semiotic intelligence through repeated exposure and consistent reinforcement of meaning. The stop sign is a visual constant on roadways alerting drivers to momentarily stop; its octagonal shape (intended to assist visually impaired individuals)

combined with a red background and white text and border define its visual meaning for the viewer. The color red may represent heat or urgency depending on the viewer's experience and base of reference. Combined with the word "stop" in white letters, red clearly means stop. Likewise, the skull and crossbones (as a unit) on a flag frequently appears in depictions of pirate ships; the round shape of the skull, the "x" shape of the crossing bones, their white color, and their position in two-dimensional space against a black background symbolize piracy. A white skull and crossbones, representing human skeletal remains, sharply contrasts with the black background to invoke fear or to signify a threat. The symbol's negative connotation has come to characterize the poison warning on bottles containing harmful chemicals. Individually perceived, each of the aforementioned visual elements communicates separate ideas, yet collectively, a very specific message emerges through their repeated use.

The corresponding acts of perception and signification, or the designation of meaning to perceptions, are instantaneous; once one sees an image, the brain provides an immediate identification or label based on prior exposure to and/or context of the image. In terms of information design, the specific graphic elements within a document and their composition must closely parallel their intended function to eliminate the possibility of mistaken meaning. For instance, an arrow ➔ commonly indicates direction or motion—no other symbol conveys those ideas more directly when clearly displayed. On the contrary, an ✖ can mean "no," "stop," and "incorrect" as well as mark a point in space, as in football strategy maps. Depending on its orientation on a surface, an ✖ can look like a ✚, which can mean "plus" or "intersection." The designer's decisions in using symbolic representations can also evoke new meanings through the creation of visual systems, such as map legends, in which a literal definition accompanies the symbol, or through the juxtaposition of elements within a given context, such as a hand paired with an arrow to demonstrate an action.

Visual representations in mechanical instructional materials specifically communicate what an object is and what it does. Arrangements of lines, shapes, and colors in drawings give the reader a sense of form and physical dimension, while signs and symbols indicate an action, object, or function. Collectively, the clues instructions offer a reader form a "mental model", or perceived image of an object and how it works.[6]

[6] Norman 17

These symbols, showing different conditions and functions on an Apple LaserWriter 8500 black and white printer, use abstract representation of the printer's parts. The symbol on the far left shows paper wrinkled between printer rollers, the second stands for a piece of paper, the third depicts a near-empty toner cartridge, and the fourth symbol appears to illustrate the motion of the print drum.

Maps mainly rely on lines, shapes, and colors to display a region, although perceptions of their position and orientation are most critical in one's ability to make associations. Relationships of distances between elements and the directions of paths connecting them construct a planar reality reflecting the reader's physical perceptions of space and relative location of one place to another.

Diagrams and conceptual illustrations present a unique perceptual challenge, as symbols and visual metaphors for abstractions serve as prompts for creative thought. Since many forms of cognitive information cannot be visualized on paper as easily as human cell division or the solar system, for instance, alternative associations and representations are necessary to enable an individual to picture concepts clearly. Also, information dealing with exceptionally large- or small-scale phenomena, such as the size of the universe and subatomic particle activity, requires a metaphorical approach to conveying information.

Perceptual experience, as the foundation of learning, underscores every step towards the internalization of information. The quantity and quality of visual perceptions leading toward the successful completion of a task are primarily determined by the design of information in instructional materials. Principles in organizing graphic elements, such as text, image, line, color, and space, shall be discussed in the next chapter on information design.

Learning and Understanding: Processing Perceptions

The cumulative effect of visual perceptions is to prompt the reader's action through interassociation of physical and representational knowledge. Attaching meaning to visual perceptions is a function of learning, wherein mental associations among percepts develop through the conscious grouping and reorganization of related data. Richard Saul Wurman offers a helpful analogy: "Learning is like Velcro. An unfiltered fact is not a complete fastener. Only one side of learning is made up of facts; the other consists of

stories, i.e. ideas and images."[7] One develops new knowledge by anchoring fragments of data to existing knowledge. In *Learning Theories for Teachers*, Morris Bigge uses the term "apperception" in reference to the "process where new ideas associate themselves with old ones that already constitute a mind."[8] An example of apperception is learning how to perform mathematical operations: once one has grasped the concepts of addition and subtraction (after having already gained an understanding of numbers and basic mathematical symbols), one can then proceed to learning multiplication and division, which build upon the previous lessons while introducing new material.

[7] *Information Anxiety* 132

[8] qtd. in *Information Anxiety* 168

Associative skills involved in visual learning include the following:

- translation of line into shape by recognition of physical boundaries
- interpretation of arrows, numbered images, and changes in placement of objects within the represented reality into action, sequence, and position
- union of text and image to complete an explanation
- ascription of a hierarchical, dimensional, or organizational system to color.

From early childhood, the development of cognitive abilities is characterized by three different "stages of learning," or "learning mentalities," based on the theories of child psychologist Jerome Bruner. Alan Kay, a computer scientist and developer of the graphical user interface, describes Bruner's three stages:

> The child of four or five thinks kinesthetically by doing—actively. Everything is done by direct actions, very tactile. Children a few years older are dominated by the visual. Their attention moves around the way your eyes move around on a bulletin board. The third stage is symbolic thinking, the practicality of translating their creative ideas into things or symbols. What seems to happen in our society is that adults turn into basically sequential processors and shut down the creative things that children are able to do.[9]

[9] qtd. in *Information Anxiety* 157

One way to apply learning mentalities to the scheme of visual learning is to consider symbolic thinking as the practice of mental association based on a collection of physical sensations and visual perceptions. For example, in the kinesthetic stage, a child learning about a flower would first "know" the flower by feeling the texture of the stem and petals, by smelling

it, and perhaps by tearing it apart. In the visual stage, the child would respond to the observable features of the flower: the green of the stem and leaves and the hue of the petals, the roundness of unopened bulbs, and the arrangement of the flower petals. When the child reaches the symbolic stage, he or she is capable of weaving interrelations of complex thoughts and of assigning personal meanings to pieces of information in tangible and abstract forms. The child may draw a picture of a flower to represent spring (a connection between physical perceptions of nature, weather, and time), or happiness (the attribution of emotional significance to sensations, such as a pleasant fragrance or intense color). Consequently, the child constructs a visual vocabulary from these primary cognitive links.

Learning is the means to understanding, for without interaction and engagement between the individual and information, the firm grasp of information cannot occur. The culmination of learning new information is understanding—the sense of realization brought about by one's awareness of the underlying structures, patterns, and correspondences of information. Understanding results almost exclusively from personal interest, an eagerness to invest one's effort into the comprehension of unfamiliar facts, concepts, and processes. Curiosity motivates learning by fostering an investigative approach to problem solving wherein one searches for less obvious associations of ideas.

One method of achieving understanding involves examining information from different perspectives. Mentally distancing oneself from the information, exaggerating the scale of the information, taking a bird's-eye view or a worm's-eye view, changing the organization of the information, and thinking in terms of opposites help one make new associations of perceptions. Each of these methods allows an individual to gather new perceptions or take notice of previously unseen features which can, in turn, lead to other questions that require further examination.

Also of key importance in developing an understanding of information is defining the purpose behind grasping the information: Why is a certain piece of information necessary to understand? What is the intended outcome or benefit of applying the new knowledge? In answering these and other similar questions, one narrows the focus of activity to one or several desired effects. If instructions create perceptual obstacles and fail to provide a path leading towards one's goal, then (one learns) the material is unusable. Decision-making is based on the options available to a person and the degree to which each option serves his or her intentions. An example of defining one's purpose is using a subway map to find the most direct route to

a particular museum. One defines the goal of reaching the museum without having to transfer to different trains or walk a long distance from a train station. A map that readily presents visual clues regarding one's orientation in space and the available options for travel assists perception and enhances understanding.

Evaluating the results of an action after one has derived meaning from perceptions and formed a decision promotes understanding by building one's experience. The cycle of trial and error broadens one's knowledge by pointing out obvious cause and effect relationships, especially with regard to mechanical and spatial tasks. Common sense, or the "self-evident" lessons of life, aids one in making judgements about situations by providing an intuitive understanding of proven "truths." For instance, one may follow a set of directions very closely only to find that the expected result does not occur or that an error has occurred; however, when one successfully "experiments" with a procedure or with using the controls of a device, one may learn that the desired effects can be achieved by alternative means. Consequently, the next time the person uses the device, he or she will have the experience to deal with that problem when it arises.

Remembering: Possession of Understood Concepts

Memory generally entails the mechanisms which preserve the details of perceptions, sensations, and thoughts. Personal interest, emotional value, and sensory cues such as written messages, sounds, and pictures all help spark recollection; each factor represents some form of internal association focused on retrieval, quite similar to the practice of association in learning new information.

Psychologist Marvin Minsky identifies the mental connections between perceptions as "knowledge lines," or "k-lines." Size, shape, color, orientation, and texture can be connected by k-lines, and each piece of visual data can constitute different k-lines; however, one must have a clear recollection of the individual perceptions to form links between each detail. When one is attentive to the distinguishing features of an image, a k-line wires them together like steady-burning Christmas lights. Remembering an image is like sending electricity through the string of lights, illuminating each detail to form a continuous recollection. However, if one forgets one or several details, the memory may lose its "glow" yet retain its place in the mind as a recollection.[10]

[10] Minsky 82-83

Drawing comparisons between and among pieces of information helps stimulate perceptual awareness and memory by magnifying subtle

differences and similarities. "Small multiples," termed by Tufte, are repeated yet slightly altered versions of information that show change, progress, and different points of view, thus distinguishing the "variables," or changing elements within a uniform context.[11] An example of a small multiple is a group of images in a first aid manual showing different wounds and how the skin tissue is affected in each injury.

[11] *Envisioning Information* 67-68

A strictly verbal description would not clearly convey the information presented in these illustrations. Features such as hair and layers of skin provide the reader with visual representations of real tissue and of the damage an injury causes below the surface.

(taken from *American Red Cross Community First Aid and Safety* 136-137)

Memory must also form a connection between past and present realities, or between the content of an experience and one's later awareness of the event. A recollection of a person's face connects the act of viewing the features of the face (the memory) and one's recognition of the act taking place. First, the degree of detail in one's perceptions of the eyes, shape of the head, hair color and style, and other distinguishing features determines the resonance of the memory through the formation of k-lines. This collection of observations establishes the existence or substance of the event at one "end" of the memory. The moment in the present when one asserts that the event did, in fact, take place anchors the other end of the memory. A weak connection may result in one of two situations: the individual may completely forget the event and the information contained in the event ("What happened? I don't even remember that ever happening."), or the individual may struggle to retrieve the contents of the memory, left with only the knowledge that something happened ("I heard him talk, but I don't remember what it was he said."). A potential consequence of this forgetfulness is the inability of an individual to interact productively and exchange information with others.

With regard to mechanical, spatial, and cognitive information, focused concentration on the details of an event, or the experience of learning a procedure, a set of travel directions, or the nature of a concept, is vital to the recollection and performance of those actions. One may read over first aid instructions and claim to understand them, but an emergency situation

would place critical demands on the individual, who could fail to provide the necessary care because he or she did not thoroughly process and understand the instructional information. Getting from one location to another may be a matter of tracing a line on a map and/or following a written list of turns, but without registering the visual cues and references one encounters along the way, one runs the risk of becoming disoriented or completely lost. A student learning the rules of punctuation may have reviewed an example-rich chapter on comma usage, yet if he or she has not studied the visual placement and context of the commas in the examples, then he or she may not know exactly where the mark should go or why.

Effective instructions, maps, and illustrations of phenomena work to implant information in long-term memory by structuring data which simplifies the process of sorting and evaluation, allowing for more vivid and instantaneous recall. Only the constructive interrelation and genuine comprehension of observations (embodied in active learning) define productive, long-term memory. Brief or unattentive visual perceptions relegate information to short-term memory since one's concentration on the information is insufficiently focused.

Associations that trigger memory are built from those that promote learning in much the same way that individually twisted hemp fibers are wound together to form rope. Added combinations of various processed and linked perceptions reinforce the impression of an idea, just as more strands make for stronger rope. To extend the metaphor, if each "strand" of perception is brightly colored or displays a repeating pattern, the "rope" of memory becomes more unique, more distinct. For example, following travel directions is a learning process that involves locating streets and roads, executing turns, identifying landmarks, and keeping track of one's surroundings to avoid becoming lost. One demonstrates understanding of travel directions when one reaches the intended destination. The strands of perception in this case are the details and order of the directions, clusters of visual perceptions: names of streets and roads, descriptions of landmarks, explanations of turns, and indications to avoid or correct error. Clear, pertinent, and sequential details create the most vivid strands of perception and consequently a durable rope of memory.

What one recalls frequently stands out prominently in memory. Knowing that turning a particular knob, pressing a specific button, or performing any combination of actions *consistently* produces (or fails to produce) an intended effect becomes ingrained in one's long-term memory. Realizing that a subway train one *frequently* takes stops at certain stations

only during rush hour on weekdays establishes a "rule" for taking that train. Extra information or steps that either do not have useful results or are not regularly practiced sink into short-term memory and eventually fade. Instructional materials "back up" long-term memory; they are a record of knowledge to which one can refer to strengthen mental associations.[12] As such, their content requires careful visual and logical structuring.

[12] Norman 58-60

A strong association between perceptual and physical realities can form through multi-sensory information and bolster one's memory of an action. "Visibility" is the physical signal that one has operated a control on a device or that a function is taking place or has already occurred and helps guide one's learning and memory regarding the use of a device. A product demonstrates visibility when the user's action, either correct or incorrect, produces a perceivable response, such as a sound, the blinking of a light, or a locked control, such as a button or knob. Computers use warning and error sounds to alert a user of a mistake or of the machine's inability to recognize or perform a command. On most Apple LaserWriter printers, a blinking green light beside the "processing data" symbol and the sound of the machine operating signal that a print job is underway. If one has not properly loaded film into a manually-adjustable 35mm camera, the film winding knob fails to turn and a slipping sound rustles inside the case as one turns the film advancing lever. Instructions that inform the reader of such built-in features show the cause-and-effect relationship between one's actions and a device's "actions," thus helping to construct a "mental model" of a device, or a general understanding of "its perceived actions and visible structures."[13] This mental model takes residence in long-term memory after one has engaged in the extensive use of a product.

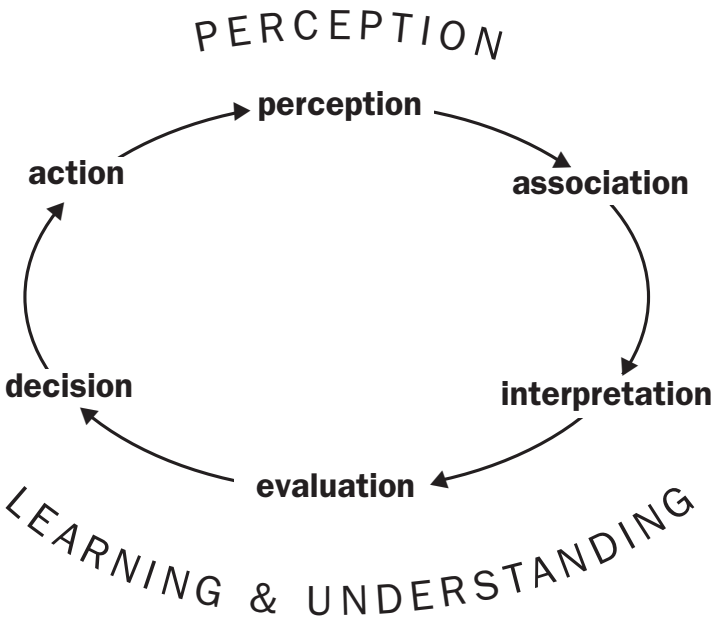
[13] Norman 58, 17

Creative and unusual mental associations enhance memory by amplifying the most striking or important characteristics of an image. Harry Lorayne and Jerry Lucas, co-authors of *The Memory Book*, describe how imaginative correspondences between ideas and images make those concepts more unique and interesting. A memory-improvement technique Lorayne and Lucas term the "Link system" requires one to think of absurd pictures linking familiar and unfamiliar ideas in a personally meaningful way. For instance, while reading a map one may visualize a building physically bending in the direction one must travel. With practice, one remembers the direction because one's understanding of the information is intensified by constructive thought and concentration instead of passive observation.[14]

[14] Lorayne and Lucas 31-36

Instructional materials help the reader form a mental link between the perceived and actual realities of an experience—mechanical, spatial, or

cognitive—through emphasizing those aspects of the experience which one would normally encounter. In the next chapter, I discuss the ways in which an information designer can construct representative realities to connect one's thoughts and actions through the organization of content and visual variables.



This diagram illustrates the thought process behind visual information processing with regard to instructional materials. It is a cycle where actions based on processed perceptions yield new perceptions from which the system repeats. Memory develops over time, when one has internalized repeated perceptions and associations and when understanding is supported by the activation and stimulation of past experience.

2 Information Design: Theory and Practice

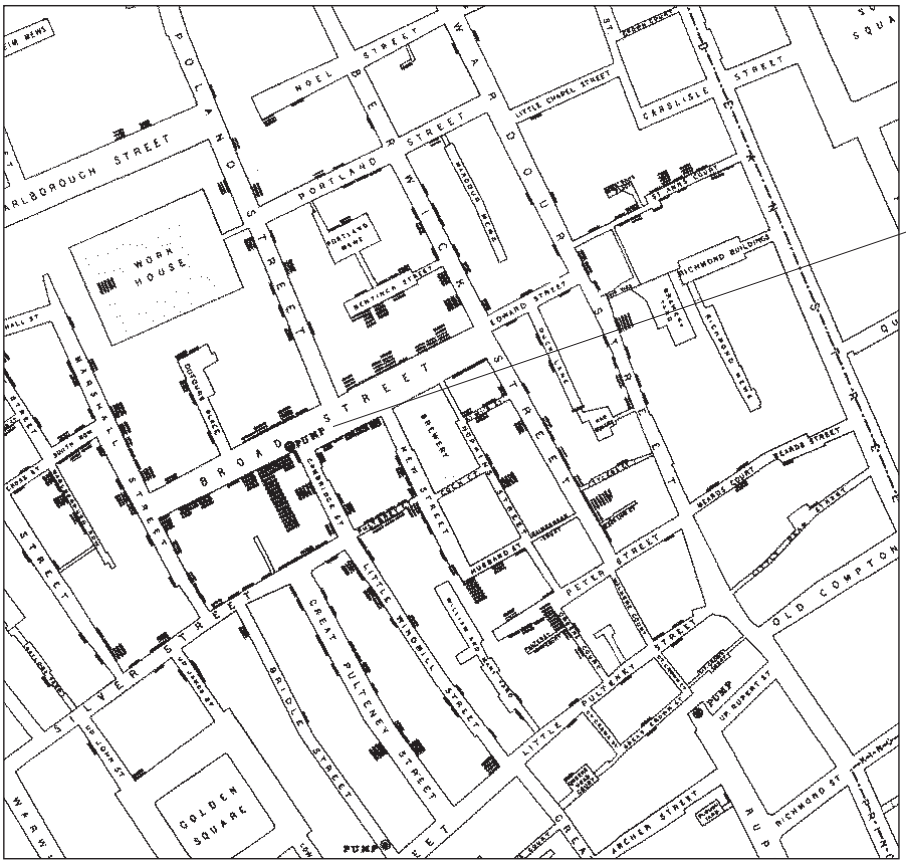
Human perception is a highly subjective act predisposed to the distortion of facts and projection of personal opinion. No standard set of guidelines exists for the design of information because of the extremely individualistic nature of visual perception as well as the differences among data, intentions, and audience. Nevertheless, guiding principles for clear communication arise from common sense (recognition of obvious circumstances), mastery of the subject matter (facts and data), and the skillful use of graphic elements and composition within two-dimensional space. Tufte sums this point succinctly: "When principles of design replicate principles of thought, the act of arranging information becomes an act of insight."[1]

[1] *Visual Explanations* 9

Organization Systems

Methods of information design suit the particular quantitative and qualitative characteristics of a given set of facts and data. Neither right nor wrong applies in describing a design technique since various systems of organization suit different needs more effectively than others. The *appropriateness* of a method is the central issue in information design. For example, to show the number of cholera deaths within a section of London, John Snow translated the numerical and geographical data onto a map of the city. When the data were previously presented in the abstraction of a list of text and statistics, their meaning was concealed. The connection of the deaths and their location became clear only when Snow presented them on a map.[2]

[2] ibid.,27-37



This detail of John Snow's map of London illustrates the number of cholera deaths at specific locations near water pumps. Snow demonstrated that the highest concentration of deaths occurred near the Broad Street pump. Subsequent to this display, the handle of the water pump was removed and the deaths decreased.

(*Visual Explanations* 30-31)

Approaches to information design take into account the underlying structure and interrelationships of data—fragments of facts, measurements, and unconnected quantitative and qualitative statements. Wurman identifies five "hat racks" for organizing information—location, alphabet, time, category, and hierarchy—known as the "LATCH" method:

- Maps organize information by **location**, or where one item lies in relation to another, along with distance and physical features, such as rivers or mountains between locations.
- Dictionaries and phone books group large amounts of textual information in the order of the **alphabet**.
- A series of events occurring in chronological order are organized by points in **time**. Assembly instructions depict a sequence of actions required to put together an object or piece of equipment. (Mijksenaar similarly recognizes that "Time, in the sense of viewing direction, is important in such activities as reading a newspaper page, filling out a form, and using a control panel."[3])

[3] *Visual Function* 41

- Scientific and technical information is often classified by **category**, or by like characteristics and features. Wurman cites the *Sears Tablesaw Owner's Manual* as being organized by categories as well as by subcategories, time, and location.
- **Hierarchy** is a measure of magnitude pertaining to the relative degree of importance or value of each item in a set.[4]

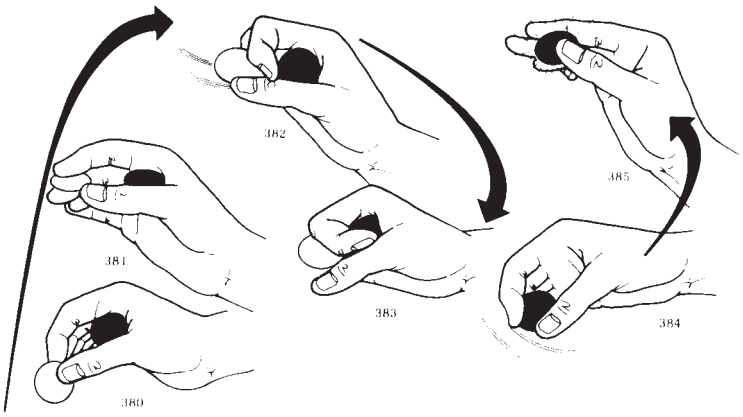
[4] *Information Anxiety* 59-65, *Information Architects* 17

While each of these methods pertains to the underpinnings of content, the creative display of data structure assists the reader's perception. A document that only shows an ordered list or table of facts and data may communicate clearly, but it may not cultivate understanding as it conforms to a limited visual "vehicle" or medium. Information that draws from a variety of perspectives and forms a strong bond between content and reader enhances visual information processing. Along with frameworks communicating logical patterns, image-based display methods organize content to maximize the quality of perception and permit the reader to form more meaningful associations.

Visually ordered systems of facts and data provide readers with models for learning that distinguish hierarchies and categories of information. "Parallelism in time and space" refers to the comparison of two distinct yet interrelated realities, or the pairing of separate points of view.[5] An information designer creates parallels of data through "position, orientation, overlap, synchronization, and similarities in content."[6] The view of a magician's hands executing the steps in a coin trick below presents a parallel in space, since it shows two concurrent realities—what the magician knows and what the audience sees. The audience sees only one coin, while the magician sees both the visible coin and the concealed coin in his or her palm.

[5] *Visual Explanations* 80-82

[6] ibid., 82



This image from *Coinmagic*, by Richard Kauffman, shows each step in a coin trick as a frozen frame. The curving arrows reinforce the sequence of events, and thin motion lines indicate quicker movements.

(shown in *Visual Explanations* 60)

"Micro/macro comparisons" show a part-to-whole relationship using an abundance of detail over a large area. This method allows an individual to selectively gather information from a variety of entry points according to interest and need, rather than settle for more generalized, less elaborate information.[7] Many maps of urban areas include buildings and structures along with acute visual descriptions of architecture, enabling one to choose the level of detail relevant to the purposes at hand.

[7] *Envisioning Information* 37-51

In this highly detailed map of a section of New York City by Hermann Bolmann, the reader can zoom in on points of interest while maintaining a sense of orientation and relativity of one location to another.

The bird's-eye view (based on tens of thousands of aerial photographs) provides a commanding perspective of a large area that otherwise would be obscured when viewed at ground level.

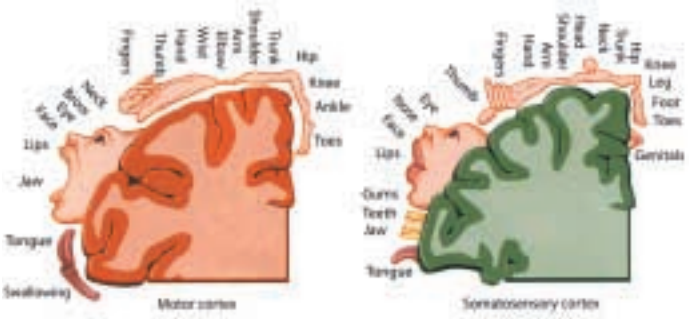
(Wildbur and Burke 128-129)

Combinations of assorted images to communicate collective meaning are visual "confections."[8] A confection is a type of collage which builds associations by placing out-of-context elements into a new context based on subject matter; the end result is a synthesis of individual meanings to form a whole, much like a rebus—the sum of descriptive fragments. As an aid to memory, visual confections provide one with inventive conceptions of information that strengthen perceptual links to existing knowledge.[9] An example of a visual confection is the "homunculus," or map of body parts controlled by different parts of the brain; pictures of the body parts and their names appear beside the governing cortical region.[10]

[8] *Envisioning Information* 125-127

[9] ibid., p. 125

[10] Gazzaniga, Ivry, and Mangun 75-76



This confection visually links parts of the body with parts of the brain that control their function. The vivid and rather absurd appearance of the body also creates a strong mental impression.

(adapted from V.S. Ramachandran in Gazzaniga, Ivry, and Mangun 75)

To evaluate the effectiveness of a particular method of information design, the information designer should consider the following questions: "Is the display revealing the truth?", "Is the representation accurate?", "Are the data carefully documented?", "Do the methods of display avoid spurious readings of the data?", and "Are appropriate comparisons and contexts shown?"[11] If instructional materials fail to meet any of the above requirements, the designer should rework the material to ensure that it is honest, accurate, opaque (rich in meaningful content), clear, and practical.

[11] *Visual Explanations* 70

Type Use and the Structure of Content

The meaning of text depends on two factors: what it communicates (written content) and how it communicates (visual quality). The appearance of text is a product of font choice, size, weight, style, kerning (letterspacing), leading (linespacing), and placement on a page. Collectively, these characteristics can either operate harmoniously with images and ease understanding or compete with them and create confusion. Aside from shape, size, and placement on a page, type is also governed by other visual variables; a designer can shade, texture, color, and orient type on a page in numerous ways.

Selecting an appropriate font, or *typeface*, depends on the specific

message as well as on the purpose and audience of the information. When used consistently, a font can be used to organize information by category or hierarchy. Serif fonts, which have finishing marks at the end of letterstrokes, are best suited for sections of descriptive text because they maintain legibility at small sizes. Traditional serif typefaces such as **Garamond** and Caslon (shown here) are highly versatile and retain clarity even after repeated reproductions through photocopying and faxing. Sans serif fonts, lacking finishing marks, work well to establish hierarchy for headlines and titles of sections, as they visually contrast serif type. Most mechanical and spatial instructional materials utilize sans serif fonts, such as Helvetica, for their clean lines. Other notable sans serif fonts include Franklin Gothic, Futura, and Meta. In most instances, no more than three typefaces should be used so as to avoid cluttering a document and confusing the reader; too many typefaces complicate and obscure the hierarchical order of different sections of information.

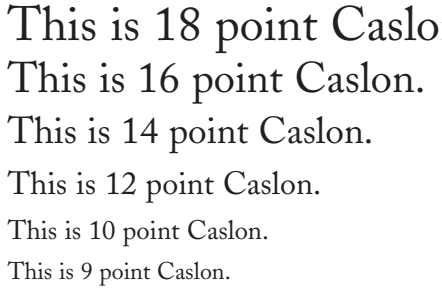
This is a serif. It finishes each stroke of the letter.

This sans serif letter does not have finishing strokes.

	lowercase	capital
rectilinear strokes	**il**	**EFHILT**
curved strokes	**acegos**	**COQS**
combined curved and rectilinear	**bdfhjmnopqrtu**	**BDGJPRU**
diagonal and rectilinear	**kvwxyz**	**AKMNVWXYZ**

These two columns of type, adapted from *Typographic Design: Form and Communication*, show four categories of type according to the shape and strokes of the lowercase and capital letterforms. In each category, the chance of misreading and confusing the letterforms depends on the specific typeface used (82).

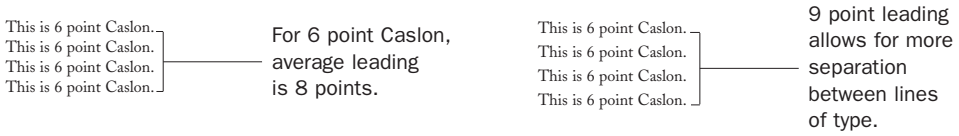
Choice of *type size* primarily depends on the audience of the instructional materials as well as the hierarchy and categories of information. Literature for the elderly and small children requires larger type around 14 to 16 point for easier reading, while text for young adults can be set as small as 9 points. Most documents are set in 10 to 12 point type for average adult eyesight. Larger type stands out beside smaller type and can be used to indicate categories and hierarchies in section headings and other divisions of text.



In this example, larger type size stands out more and appears bolder than smaller type. While smaller type looks like a grey line, it is widely used in tight spaces or to signify information that is necessary but too lengthy to set in a larger size.

X-height is the distance from the baseline to the top of a lowercase letter.

Linespacing, also called leading, varies with audience along with the type size, line length, and the amount of text on a page. As a general rule, leading is about two points more than the type size to enhance legibility. However, leading depends on the x-height of a typeface, or the distance from the baseline to the top of a lowercase letter. The type in this paper is set in 12 point Caslon with 15.5 point leading for more separation between lines to ease prolonged reading. Smaller type calls for increased leading when used heavily, as in instructional materials printed for small devices, such as personal radios and digital wristwatches.



Letterspacing, or *kerning*, is the space between individual letters. If linespacing is too close or open, excessively loose or tight letterspacing can compound difficulty in reading, especially with small text.

loose T h i s s e n t e n c e i s h a r d t o r e a d .

tight This sentence is also hard to read.

normal This sentence is easy to read.

The *weight* of type, characterized by the terms "**bold**" (thicker strokes) and "regular" (moderately-thick strokes), affects a reader's perception of categories and hierarchies of information. Bold type usually indicates section headings, labels, and highly important information since it contrasts the body text and catches the reader's attention. Regular type is used in long sections of text as the body type. Type that is all bold can appear too dark, while all regular weight type runs together, unless sections are offset on the page. However, bold text in instructions is easier to read in low-light conditions and stands out more clearly against a dark background.

This passage is bold. Its dark appearance makes the text heavy and dense on a page. Consequently, one may be disinclined to read through an entirely bold section of lengthy text because of the excessive contrast between the text block and the page. The lack of "air" or room between the shapes and strokes of the letterforms can also hamper reading. In this case, small type and tight leading can strain the reader further.

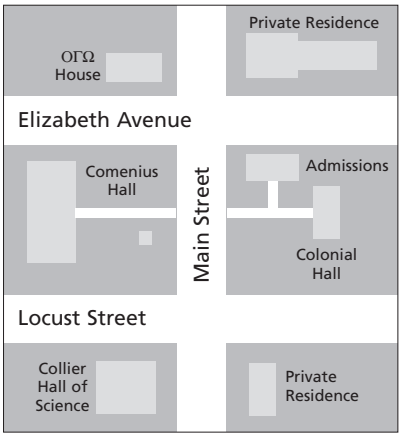
Type style refers to the particular way a typeface is drawn and can also distinguish categories and hierarchies of information. *Italic* type is slanted and curved while retaining the distinctive characteristics of its regular form; it stresses important words and moderate-length sections of text. Small caps (shown here) are capital letters at lower case height used for titles and section headings but not for long passages.Variations of upper and lower case type in text conform to standard English writing practices and result in more recognizable words; capital letters commonly denote beginnings of sentences and first letters of proper names. If text is entirely capitalized, these denotations of meaning become lost or hard to identify.

Placement of type on a page creates connections and separations between elements, which affects comprehension. Of considerable importance to comprehension is the direct connection between both verbal and visual languages. Simultaneous viewing of both word and image helps unify the acts of explaining and demonstrating. When text and pictures are placed on separate pages, the reader is constantly forced to turn pages when each image reference, such as *Figure 1* or *Plate A*, appears within the text.[12] Repetition of images, though costly in terms of print space, also enables the reader to revisit a visual representation of an idea when its textual reference reappears.[13] Labels for parts or objects as well as place names should appear near what they identify. If a label is too far away, it may lose contextual meaning or end up identifying another item. Information with considerable visual detail, as in a city map, calls for small labels in close proximity to items.

[12] *Envisioning Information* 63

[13] ibid., 116

Type is easier to read when set horizontally, as opposed to being positioned upside-down, vertically (with individual letters horizontal or with words reading from bottom to top), diagonally, or upside-down. When space constraints disallow horizontally-positioned type, words and numbers can be angled to maintain readability from left to right; extreme space limitations, particularly in maps, may call for vertical positioning of type reading from bottom to top.



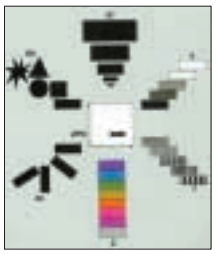
This highly simplified map showing a section of Moravian College's Main Street Campus employs a consistent typeface for all labels. Each building is identified using a horizontal label, while street labels follow the direction of the roadway.

Indentation and *spaces* between sections of text help to separate ideas and shifts in thought clearly. Paragraphs and items in a bulleted or numbered list call for more room between each unit of information.Text that is set as one straight, unvariated block or column creates a uniform grey shape that is difficult to read for an extended period. Typical paragraph indentations extend five character spaces; drastically short or long indentations may look awkward or distracting depending on type size and linespacing.[14] Lists may be indented ten character spaces to offset them from body text.

[14] Carter, Day, and Meggs 82-89

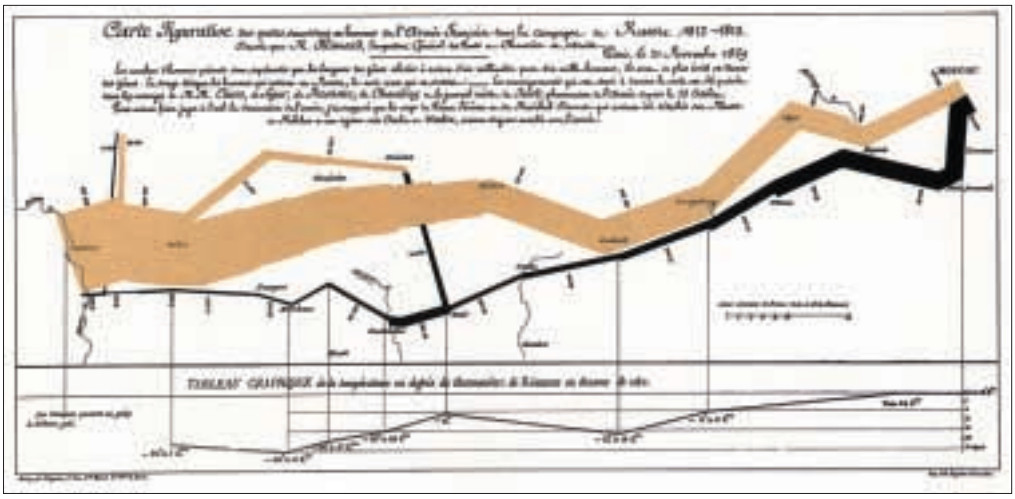
Techniques for the Design of Visual Variables

Information design methods employ elements such as lines, shapes, colors, and type to signify and to differentiate pieces of information; however, these elements, along with variations in texture, size, value, orientation, and position on a page can either clarify content or obscure it depending on their use. The designer's job is to decide on the most appropriate means of representing information by first identifying the most essential pieces of information, sorting them into groups based on like qualities, and defining the variables for each category or layer of information.



Bertin's Visual Variables

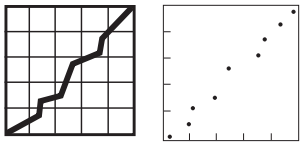
Jacques Bertin's visual variables represent the building blocks of two-dimensional design; size, shape, texture, value, color, orientation, placement on a page, and type encompass the range of visual perceptions at work in information design. Each variable performs one or several functions depending on the organization of information. Charles Joseph Minard's 1869 chart of Napoleon's march into Moscow during the war of 1812 displays several kinds of information by applying variations of the visual variables.



Distance and the number of soldiers at points along the journey appear as orange and black lines of narrowing thickness (marches east and west), rivers are thin black lines, and temperature and elevation are represented by a line graph at the bottom of the chart with lines pointing to different locations along the trip.

(*The Visual Display of Quantitative Information* 40, 176)

Careful evaluation of associations between data and facts reveals their most direct, comprehensible relationships which suggest ways of identifying their comparative significance. The assignation of perceptual characteristics for information through the definition of visual variables involves a number of considerations for appropriateness.

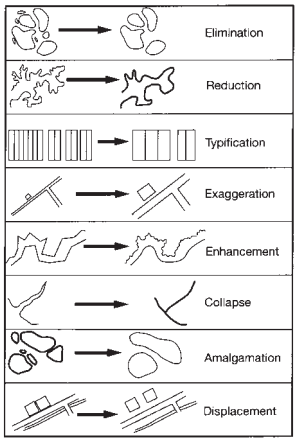


The chart on the left uses heavy line weights to show a positive trend, while the one on the right applies the "smallest effective difference" to display the same information.

Size and Shape

One guideline for determining the size of an element is showing the "smallest effective difference" by minimizing the visual weight of marks on the printed page.[15] The size and shape of elements should be distinctive enough to provide the information user the appropriate perceptible clues to see the framework of the content. The smallest effective difference applies to rules, outlines, frames, grids, and other linear marks; when thin and/or gray, they give just enough indication of separation between different items.

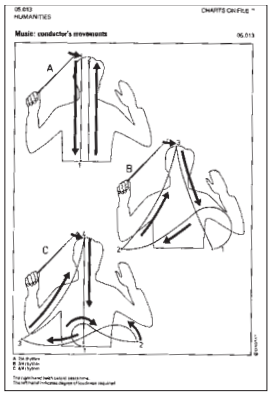
[15] *Visual Explanations* 73-77



This chart shows eight ways to simplify linear marks representing geographic features. Pictured from top to bottom are *elimination* of minor shapes, *reduction* of curves, *typification* of like elements, *exaggeration* of scale, *enhancement* of edges, *collapse* of open shapes, *amalgamation* and *displacement* of close shapes (Jones 274).

In this sign directing people to a bus stop, the heavy weight of the arrow suits the needs for visibility at a distance. The comparable bold weight of the bus symbol connects well with the arrow.

("Graphic Symbols" 125)



The diagram above from *Charts on File* uses moderate-weight arrows to clearly trace the rhythmic movement of the conductor's baton.

(Wildbur and Burke 56)

Arrows serve a number of purposes in instructional materials, but often their message is either over or understated. "Secondary structural elements," also referred to as "supporting variables" by Mijksenaar, such as arrows, tic marks, scales, grids, rules, frames, boxes, legends, shadows, and fills are often overused or unnecessary in the clear communication of information.[16] Secondary structural elements are most effective when subtle and subdued, creating a balanced visual field in which content assumes primacy.[17] Marks on a page should serve a purpose or, ideally, several purposes, if the reader is to understand the information without having to contend with misleading surface decorations. Tufte concisely makes the point: "In an architecture of information, the information becomes the interface."[18]

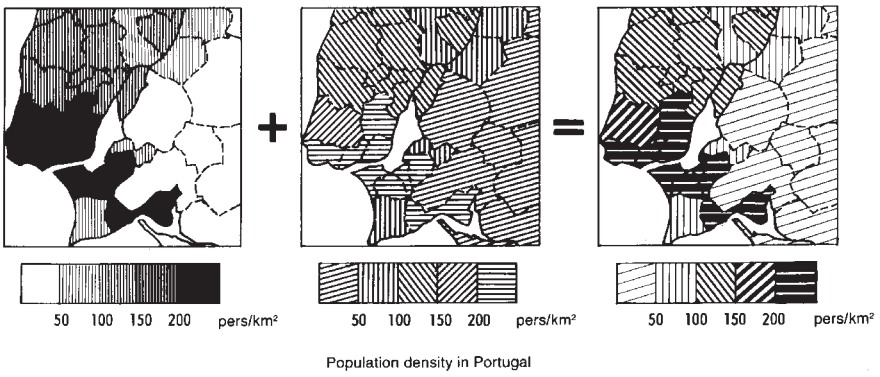
[16] *Visual Function* 38-39

[17] ibid., 74

[18] *Envisioning Information* 47, *Visual Explanations* 146

Texture

Texture is the pattern or arrangement of marks within a shape, such as dots, hatch marks, and other ordered, repeating elements. When color cannot be used, texture helps show differences in information, especially in maps where geographic areas require additional separation and distinction beyond outlines. Changes in magnitude, such as depth and height, and surface features, such as buildings and fields, can be represented by textures. However, when overused or applied to large background areas, texture creates a vibrating effect that can distract the reader.



Population density in Portugal

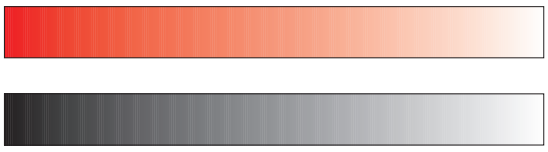
Each map in this example uses texture differently to separate areas with different populations in Portugal.

The first map is the most effective since it shows clear distinctions between areas, while the center map is uniform in appearance with blurred boundaries. The third map combines the sharp contrast of the first with the angled line texture of the second, although the separation of regions is still hazy towards the top right corner of the map.

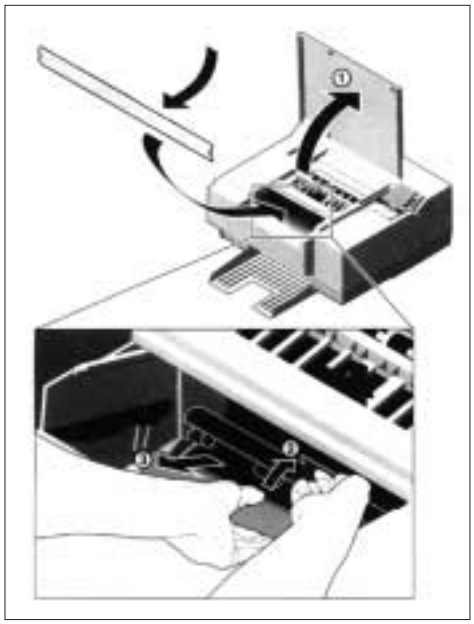
(*Semiology of Graphics* 186)

Value and Color

Value is the relative degree of lightness or darkness of a color, also illustrated by the gradations of gray between black and white:



Like texture, value can show quantitative differences. In addition, it can also create the sense of dimension and space. Realistic rendering of objects and structures using value in the two-dimensional plane aids the viewer's recognition of form and and space in the physical realm. Maps that show buildings in three-dimensions using perspective line drawing and value rendering are more effective than plain line drawings as visual substitutes for reality; perceptions of light and dark in print equate with actual sensations of highlight and shadow.



The dimensionality of the printer in this illustration from the TekPhaser III PXi fuser wiper installation instructions helps a reader associate the procedure to physical experience. The fixed light source (from above right) creates the highlights and shadows on the printer.

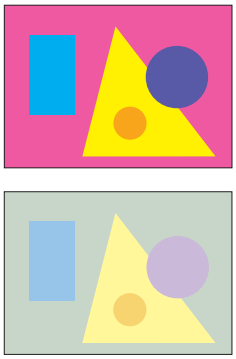
The close-up illustration on the bottom conveys the depth inside the printer where the fuser wiper is installed.

Color use depends largely on the types of facts and data depicted. The presence of color on a page notes categories and establishes a visual hierarchy that affects the reader's perception of information. A color's hue, or pigment; saturation, or intensity; and value, or lightness or darkness, can emphasize or de-emphasize one piece of information in relation to another.

The Swiss cartographer Eduard Imhoff set forth rules of color use for maps in the mid-1960s. He stated that overly vivid and intense colors are too strong, and that sparsely used, light-value colors help information step forward. In *Cartographic Relief Presentation*, Imhoff's first rule includes the following:

> If one limits strong, heavy, rich, and solid colors to the small areas of extremes, then expressive and beautiful colored area patterns occur. . . . Large area background or base-colors do their work most quietly, allowing the smaller, bright areas to stand out most vividly, if the former are muted, grayish, or neutral. [19]

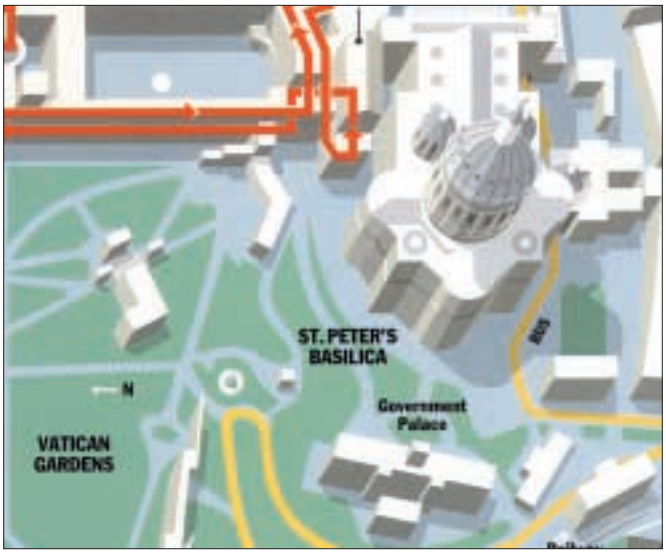
Imhoff's subsequent color guidelines discuss the size and placement of colors of different values. He suggests avoiding placement of vivid colors side-by-side or in large amounts; otherwise, the product becomes visually unbalanced. Middle-value colors work best as neutral fields upon which pastel-like colors or small areas of intense color can stand out. Individual colors should be interspersed wherever possible to avoid static sections of flat color.[20]



In the top composition, colors are bright and saturated, while colors in the bottom composition are muted and soft. Lower intensity and lighter value stimulate visual perception more effectively with less visual impact and display a sufficient degree of difference in hue.

[19] *Cartographic Relief Presentation* 72

[20] ibid., p. 72-73



This section of a map from the Vatican Museum guide by John Grimwade uses both intense and light-value color to show travel routes and the dimension of buildings. Such a representation of reality helps a reader perceive the shape, size, and spatial relationships of landmarks.

(*Information Architects* 104-105)

While color can directly note distinctions, illustrate realistic dimension, and show order, it is limited in its overall effectiveness. A color may appear relatively dull against a background of similar value; the same color may vibrate when paired with its complement (e.g. red and green, orange and blue). Certain types of color blindness affect perceptions of slight value differences, thus preventing some individuals from successfully distinguishing colors such as light blue from light green, for instance. In cases where color is central to a system of organization, other ways of clarifying meaning are necessary; the red, amber, and green signals of a traffic light are arranged vertically to provide the color blind with an alternate means of understanding "stop," "slow down," and "go."[21]

[21] *Visual Explanations* 93

In this example of color use, each combination of colors directly affects perception. The top illustration is the most difficult to read because there is little contrast between yellow and white. The center illustration uses colors of competing intensity, which are also difficult to read. High contrast between colors, as in the bottom illustration, enables the reader to discern shapes and letters quickly and easily.

The symbolic value of color (mentioned in Chapter 1) can reinforce meaning when used effectively. Red, yellow, and orange are "warm" colors because they correspond with sources of heat, such as the sun. Blue and purple are "cool" colors because they relate to ice and water. Indications of temperature, consequently, are shown by red (hot) and blue (cold). Earth tones, particularly green and brown, represent nature and appear in maps showing geographic features such as forests and mountains. Applications of color symbolism succeed when the designer's audience is familiar with the significance of a color's conventional meaning; otherwise, color simply distinguishes elements or establishes hierarchy.

Arrangement of Elements

The two-dimensional plane of space is the foundation upon which a designer arranges graphic elements. Without a surface or vehicle for communication, ideas and images are intangible, existing only as mental constructs. Enough information must occupy the graphic space for the reader to perceive and process. Bertin states that the "graphic density," or the amount of visual information in a graphic plane, should be neither excessive nor sparse; too many marks and elements cloud information and hamper perception, while too few prevent substantive perceptions.[22]

[22] *Semiology of Graphics* 46-47

Labels are oriented on or near horizontal level unless they identify vertical elements such as north-to-south streets and train lines.

Detailed bus and train information at a location is presented in a "call-out" box whose shape stands out prominently.

The New York City Subway map pictured here is a redrawing by J. Taurenac of Massimo Vignelli's diagrammatic version. This version effectively conveys information about the world above ground (topographic information) and the world below (diagrammatic information) with moderate graphic density. ("London Transport Map" 36-40).

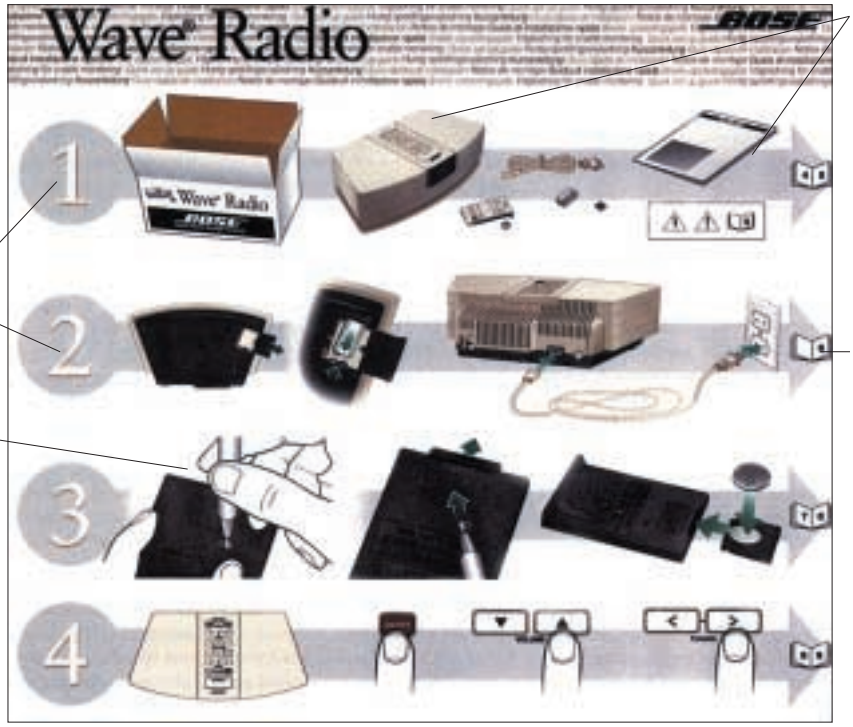
Saturated colors mark train lines prominently, while lighter colors represent surface features.

Mechanical Information: Step-by-Step Learning

The design of mechanical instructional materials is limited by a number of factors. As mentioned earlier, the sense of time and articulated motion (e.g. movement of limbs) are hard to convey through purely visual means. The subjectivity of human perception and interpretation further restrict the efficiency of instructions, as all individuals think and comprehend information differently. Physical sensations such as sound, touch, taste, and smell escape precise verbal and visual description; only general statements regarding their qualities can be communicated by graphic means.

In light of these factors, the objective for assembly instructions and operation manuals is to present, simply and directly, the necessary information to engage in a task and complete it successfully. The primary motive of mechanical information design is to narrow the gap between one's perception of the object and its graphic representation.

Detailed illustrations and explanatory text are the main components of effective instructions. Their interassociation in meaning and sequence guide the reader through a procedure. Additional elements, such as lines, numbers, and areas of color, weave together text and image by directing the reader's attention.



The almost entirely visual format of Tufte's redesign of instructions for a Bose radio avoids the need to include text in several languages ("Sermon" 44).

Large numbers help emphasize the order of steps.

Realistic scale illustrations reinforce the reader's ability to identify parts.

Subdued color is used to render objects and to emphasize the directional arrows which unify each step.

References to corresponding pages in the instruction manual help the reader access more technically detailed and culture-specific information.

Spatial Information: Getting from A to B

As with mechanical information, transportation maps help one to complete a procedure, namely travel, with the goal of reaching a destination. One must maneuver oneself in space and time, travelling from one location to another moment by moment, by following one or several paths marked by lines, colors, and symbols.

For one to understand where one is in relationship to a destination, prominent structures, such as buildings and statues, and the paths connecting them require prominent marking and visual interconnection. Shapes and text convey specific locations, and colored or textured lines trace individual travel routes. Dots and open circles, as fixed points in space, read clearly as train stations, although small boxes may not show stops along a train line as well if they are a different color from the train line or if they are too small to be noticed.

Transfer stations appear as circles and ovals atop train lines, while individual stops appear as small rectangular branches off of the train lines

Consistent line weight and bright colors identify each train route.

Station names are clearly labelled with sans serif type, and terminals are distinctly highlighted.

This redesign of the Berlin railway transit map by Erik Spiekermann presents spatial information in a diagrammatic format derived from London Underground map designer Henry Beck.

Angles of 45˚ and 90˚ simplify directions of travel, and no indications of surface features appear, with the exception of symbols for airports and accessiblility for the disabled.

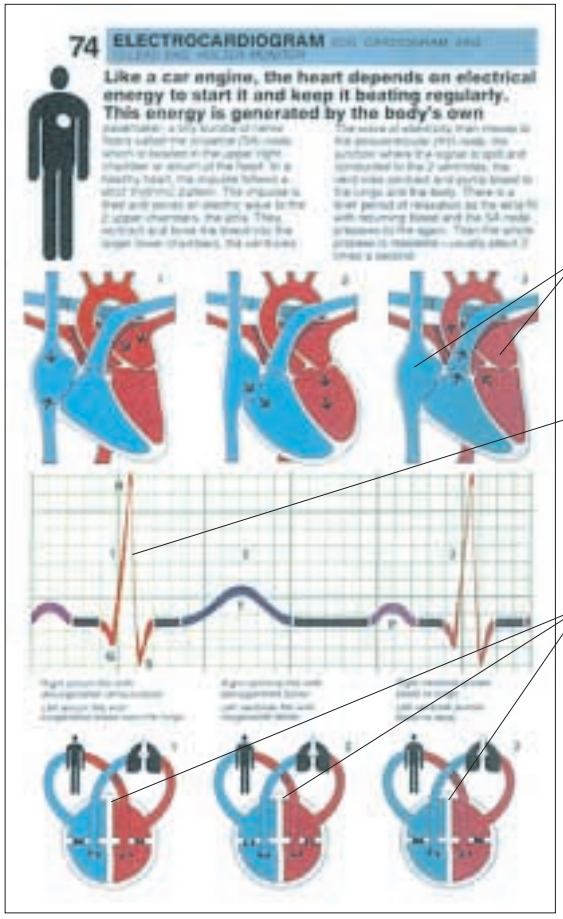
(*Information Architects* 44-45, "London Transport Map" 36-37)

This detail of an earlier Berlin train map exhibits a high graphic density since many pieces of information are compacted within a small space. Layers of information appear as a mesh of colored lines, shapes, words, and numbers.

(Gottwaldt 35)

Cognitive Information: Creative Visualization

Concepts whose physical manifestations are either nonexistent or normally unobservable present a unique information design challenge. An information designer has to choose the most appropriate association to reality or relationship to an existing physical or mental framework in order to capture the meaning of a concept. Since abstractions in science, mathematics, language, and other areas of study are so highly diversified, their design depends on the information designer's understanding of the content and ability to condense it into an appropriate metaphor composed of graphic elements and visual variables.



This page from Wurman's Medical ACCESS *guide uses color, shape, and line to distinguish different types of information.*

(Wildbur and Burke 74-75)

Oxygen-poor blood is represented by the color blue, while oxygen-rich blood is represented by the color red.

The electrocardiogram line between the two sets of diagrams unifies them by showing what each phase of the heart beat registers in electronic measurement.

The simplified diagrams at the bottom show blood flow from the lungs to the body via the heart. Their positioning beneath the diagrams at the top of the page links their information, as do the shapes of the hearts and the red and blue colors.

3 Human Dimensions in Information Design

An information designer negotiates issues of content, technique, and human needs for helpful instruction. The reason for instructional information is to enable one to gain new knowledge and to apply it toward a goal, be it putting together a bicycle for one's son or daughter, getting to a friend's new house, or visualizing how a planet travels around the sun. Effective information design is reliable; it provides one with a definite picture of the goal and the most accommodating path to reach it. Poorly designed mechanical and spatial instructional materials risk stranding an information user when a procedure or direction fails to produce an expected result. Tufte stresses the importance of consideration for users of information by stating that ". . . the operating moral premise of information design should be that our readers are alert and caring; they may be busy, eager to get on with it, but they are not stupid. . . Disrespect for the audience will leak through, damaging communication."[1] A committment to the reader must underscore an information designer's work—promoting understanding for the widest audience possible.

[1] *Envisioning Information* 34

By carefully arranging words and elements in a document, an information designer constructs a system of visual cues which "lead the way" through content so that one may develop confidence using it and ultimately gain control of the material. An individual can consequently use the knowledge he or she has come to possess to resolve problems arising from inability, inexperience, or unfamiliarity with different situations.

In planning the design of instructional materials, an information designer must be aware of two critical human issues:

- Many people think that they don't understand something because they are lacking in intelligence or ability.
- Companies overlook or neglect the fact that they must provide consumers with documents that make sense.[2]

[2] Schriver 32-33

The design of a product itself dictates the effectiveness of instructions; no matter how well-designed they may be, good instructions cannot make up for a poor product. Similarly, a badly engineered travel route or system complicates map design, for once subway tunnels are dug and the train tracks laid, a map must conform to the reality of the transportation path. An exception is cognitive instructional material, which describes a reality rather than explains how to interact with it. A diagram or conceptual visualization misleads only when the designer errs by inaccurately displaying the information or by selecting an inappropriate vehicle to represent the information, which weaken the reader's ability to make personally significant associations.

The following factors determine the type of interaction between instructional documents and their users:

- interest and attention
- motivation
- fear of failure/displeasure
- time and effort

Interest and Attention

From the moment of initial perception, one determines whether or not a set of instructions or a map is welcoming or off-putting. A 400-page computer manual densely packed with small type and few illustrations does little to encourage one to read it, although this format is common practice among many companies who often sacrifice conscientious form and function for pure data and verbose content. Usefulness and aesthetic appeal invite a reader and activate perceptivity to details. "Friendly" instructional materials, characterized by logical organization, lightweight yet meaningful graphic elements, concise text, and practical physical design engage interest and help to make information accessible.

Touches of humor and entertainment work to enhance one's interaction with information, as in David Macaulay's book *The Way Things Work*, which visualizes cognitive concepts behind mechanisms through the use of comically rendered illustrations and exaggerated scale. London-based information designers Peter Grundy and Tilly Northedge similarly take a light-hearted approach to their work. Grundy states: "If you present things exactly functionally, people will ignore them. If you can entertain them a bit, entice them, then you will attract a larger audience." [3]

[3] "Let Us Explain" 50

The cognitive illustration above, representing the effect of a heart medication, is from a series of stamps on advances in medicine. Expressions of pain and relief on the faces of the two figures, the small "explosion" between the drug and the disease-triggering agents, and the vibrant colors make the information emotionally and dynamically significant.

("Let Us Explain" 55)

David Macaulay's illustration showing how a zipper operates is both informative and playful. One can easily see how the moving part of a zipper fastens and disengages the strips of teeth. The use of exaggerated scale and human figures pulling the zipper make for novel and amusing information design.

(Macaulay 21, 358)

Motivation

Everything one does is driven by some force, be it positive or negative. Motivation propels one towards a reward—pleasure, satisfaction, relief, convenience, or any other positive result. A recent purchase, a trip to a new place, and a gnawing curiosity about a concept or phenomenon motivates one to learn, to gather as much information as possible to ensure the most "good." The urge to acquire more knowledge subsides when one encounters instructional materials that impede one's progress. One's determination may overcome obstacles of ineffective design, such as technical jargon, illegible type, unclear illustrations, or unhelpful procedures, although confusion or failure almost inevitably leads to discouragement. Perseverance rewarded by success strengthens one's self-confidence and may prompt one to pursue other "challenges."

Concern for others, especially loved ones, may also motivate one to engage in a task. Assembling a bicycle for one's child demonstrates a parent's effort to ensure the child's happiness and contentment in spite of the difficulty of the task. However, if the parent is unsuccessful, he or she must contend with the child's disappointment as well as an inner feeling of failure.

Displeasure and Fear of Failure

Often one does not embark on a new undertaking or unfamiliar experience to avoid potential displeasure. This feeling of anxiety usually leads one to circumvent the problem and seek the assistance of another who is more knowledgable or skilled in a particular area. An "expert" can tailor his or her explanation to suit an individual, demonstrate how to perform procedures, and answer questions as they arise. In place of human assistance, instructions offer the essential information one needs to achieve a goal or series of goals, but only in visual format. Engaging in some new activity alone while using ineffective instructional materials can cause a considerable degree of frustration (from not enjoying immediately positive results); nevertheless, the experience of failures and mistakes provides one with new knowledge from which skills can develop.[4]

[4] Minsky 96-97

Repeated failures deteriorate self-esteem. "Bad luck" with machines or electronic equipment may cause one to view oneself as manually inept, even though carelessly designed products and instructions may be at fault. A "poor sense of direction" may result from a lack of visual cues and spatial references in maps combined with inconsistent signage rather than low intelligence or failing memory. A fear of numbers may be a consequence of unpleasant classroom experiences, hard-to-read textbooks, and falling behind in class rather than an inability to perform calculations.

Well-designed instructional materials reassure the reader through the use of more natural, less artificial language and pictures. Effective instructions anticipate problems and guide the reader through errors towards solutions. When one comprehends information, one succeeds and experiences heightened self-esteem. Supplemental information available through customer service phone numbers in mechanical instructions, information booth locations in maps, and listings of additional learning aids in cognitive instructional materials offer one additional support and guidance.

Time and Effort

Time and effort influence one's decision to interact with and ability to understand instructional materials. Lengthy manuals with very small type and few-to-no illustrations require more time and effort from an individual than shorter, visually-based instructional materials. Images can communicate a large amount of information efficiently in a compact space.

Growing personal responsibilities and limited recreational time place demands on an individual to do as much as possible in a short amount of

time. In order to keep up with the pace of life, one must manage both daily responsibilities and momentary "distractions" from routine. Correcting a problem with a desktop printer at work, getting to a special event by subway, and trying to picture how a physiological process affects one's health call upon the skills of gathering, processing, and evaluating information "on the go."

To compensate for a shortage of time and restricted effort, one may seek another's help or ask him or her to complete a mechanical or spatial task. The "enlisted" individual would take over the task and presumably succeed if he or she is adept at tackling and solving particular problems. For example, one might hire a computer technician to assemble hardware and perform software installations. Likewise, one may hail a taxi in an unfamiliar city to get to a location quickly without having to figure out the city's subway system. In both instances, the individual completing the task is motivated by a financial reward for his or her time and effort. The guarantee of substantial personal gain lessens the burden of time and effort by rewarding skill.

4 Considerations for Effective Information Design

The process of information design involves three primary participants:

- the company or agency manufacturing a "product," of either physical or informational content
- the end-user, who must use the company's or agency's product
- the designer, responsible for structuring the content of the product to suit the needs of the end-user

Each member contributes to the overall quality and effectiveness of instructional materials. In the simplest sense, the institution creates the data or matter which the designer assembles into information for the end-user's "consumption." However, the process does not end when the "end-user" receives the information; his or her use of the instructional materials can influence future manufacturing and design if the company or agency is notified about problems and errors.

Below is the series of steps in the information design process, which also bears relevance to other creative undertakings such as writing:

1. Define the *purpose* of the information.
2. Understand the given *content* or *function* of a product.
3. Find an underlying *structure* of information that facilitates perception and comprehension and fulfills the needs of a particular audience.
4. Apply the most suitable *design* of visual variables and define their characteristics according to the structure of information.
5. *Evaluate* the usefulness of the material by testing and retesting its performance.
6. *Revise* the design until the information reaches its most consistent, comprehensible, and efficient form.

Purpose

To begin an information design project, a designer must consider the purpose behind his or her task. Defining the goal behind instructional materials enables the designer to determine his or her design methods. If the purpose is to assemble or operate a product, the design of the instructions should focus on helping one perform specific actions as easily and quickly as possible to optimize use of the product. The purpose of a transportation map is to show all possible travel routes between locations in a region. A subway map should depict general spatial relationships and indicate points where one can begin and end travel. Diagrams and conceptual illustrations dissect, magnify, and simplify the intangible or the invisible within and beyond human experience. To accomplish this, cognitive instructional materials depend on the richness of available data and the ways they can be presented to reveal their function. They are projections of mental images, inventions based in interpretive association, directed toward ready comprehension and recollection.

Content

Numerical data, facts, measurements, observations, and actions define the substance of information. A designer cannot create honest, reliable instructional materials without solid content. Data and facts become information when a designer carefully examines detail, draws comparisons, makes associations, and evaluates their relative significance. Understanding content involves the designer's direct experience through operating equipment, assembling a product, riding a city's subway trains, or researching a concept. Once a designer has "mastered" content, information structures and thought forms become self-evident.

Structure

The shape information takes must be logical and true to content. Structure supplies the reader with a pattern of thought, an ordered scheme permitting unobstructed perception. It should eliminate problems that may interfere with the reader's learning and understanding. How a designer organizes content relates to an audience's experiences and base of knowledge; structure that oversimplifies may insult the reader's intelligence, and inadequate organization can create clutter, obscuring content. A balanced information structure is comprehensible to a wide audience and presents the most rational relationships by improving perception and recognition.

Design

Assigning perceptual characteristics to structured elements characterizes the visual design of content. Graphic elements, such as lines, shapes, symbols, words, and images, take on very specific meanings with the adjustment of the visual variables—size, shape, texture, value, color, position, and placement on the two-dimensional plane. Consistency in method secures the uniformity and coherence of elements on the plane and establishes a system by which one can easily form logical associations.

Practicality is as much a consideration in the production of print instructional materials as is the quality of their content. Conscientious design helps make meaning visible; instructional materials are successful when they satisfy the needs of the information user. Performance deals with providing visual information "in the field" through an appropriate "vehicle" or physical surface for reading. A foldable city map on laminated paper suits the rigors of travel: it is water-, wrinkle-, and tear-proof, stain-resistant, and portable. Coupled with effectively designed information, this document would perform successfully after continual use. Similarly, computer manuals constructed with a spine that allows the document to lie flat permit the user to simultaneously read and carry out instructions. Erik Spiekermann and E.M. Ginger describe the functional aspects of a cookbook:

> People read cookbooks and other how-to manuals in situations that are often less than ideal. A cook book has to compete for tabletop space with food, knives, towels and bowls, and there is never enough time to read anything carefully. The text has to be read while standing, which means the type should be larger than usual. The recipe steps have to be clearly labeled with short headlines; ingredients and measurements have to be in lists that can be referred to at a glance.[1]

[1] Spiekermann and Ginger 141

Spiekermann and Ginger also cite instructions for attaching automotive snow chains. The fact that "This operation is usually done in the dark, when you're wet, in a hurry, and uncomfortably cold" makes the task more challenging than it already is. To assist the user, Spiekermann and Ginger suggest heavy type printed in black against a yellow background on the plastic packaging itself to ease reading and withstand moisture.[2]

[2] ibid., p. 141

Many objects and pieces of equipment have instructions printed directly on them or attached directly to their surface. Newer models of photocopiers include step-by-step instructions for removing paper jams and installing toner affixed to the inside of a cover. This eliminates the need to

search for an operation manual by presenting all of the necessary information to complete the task "on site."

Evaluation

The success of a design is a measure of the reader's interest in the information, the time and effort required for the reader to draw meaning from the information and complete a task, and his or her level of retention.

Feedback from the users of instructional materials informs a designer of the difficulties the materials present or the helpfulness they offer readers. Analyzing the use of a manual to assemble an object, studying travel decisions based on consulting a subway map, and testing one's knowledge of a concept after he or she has studied a cognitive illustration provide a designer with valuable clues regarding the effectiveness of a design. User response reveals what aspects of content were most or least beneficial, and what attitude the materials evoked in the reader—whether the user actively engaged in the learning process or simply performed actions with disinterest.

Revision

Effective design emerges from countless revisions and re-examinations of material until the designer achieves the clearest, most efficient system of communication for a particular purpose. The final version of a design displays accurate content, visible and comprehensible structure, and an inviting presentation. Each aspect of the finished product reinforces the original purpose of instruction and fulfills an obligation—to serve the widest possible audience in the most honest and meaningful way.

5 Ineffective Design: Gaps in Content, Form, Function

Shortcomings on the part of the information designer, the quality and quantity of information, and the visual appearance of the information cumulatively result in ineffective design—materials that mislead the user, cloud or distort data, and hamper understanding. In *Information Architects*, Wurman presents a hypothetical situation that sheds light on the nature of bad design:

> A company invents or develops some new piece of electronic hardware. When it is finished it calls in a designer to wrap it up in a nice package. Then the company gets an engineer who understands how it works to write the instruction booklet. He suffers from the disease of familiarity, and so few customers really learn how to use the product. The designer picks the typefaces in that booklet and (maybe) puts a cover on it. The designer is not involved in the use, organization, or understanding of the instructions, except tangentially to make it easy to read.[1]

[1] p. 16

The poor quality of communication between the company and the consumer in the form of the instruction booklet represents the lack of communication and cooperation within the company itself, most notably between the engineer and the graphic designer. The engineer, charged with the task of writing the instructions for the product (although technical writers normally do the writing), is so well-acquainted with its operation that he or she has forgotten what it is like not knowing how to operate the piece of equipment (the condition referred to as the "disease of familiarity"). Since the instructions make sense to the engineer, he or she assumes the reader should have no difficulty understanding them. However, consumers reading the engineer's instructions are left confused and bewildered by the technical jargon and unclear diagrams (if any) in the booklet.

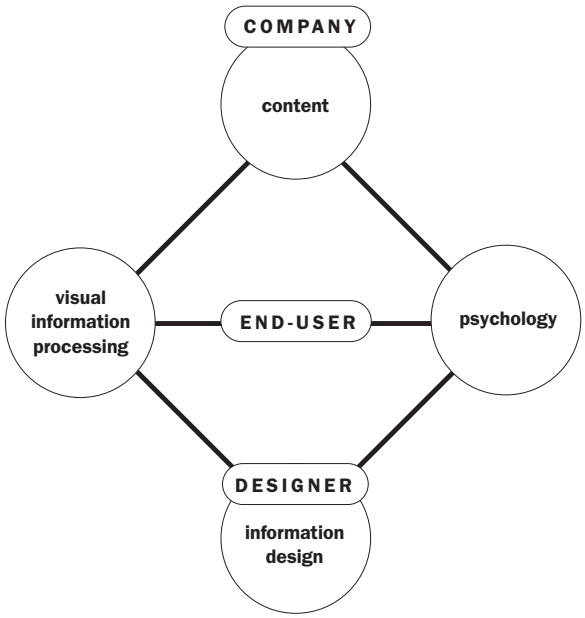
Another reason for the poor quality of instructions is the fact that some companies set strict guidelines for the format and design of instructions out of convention and convenience. Time and money—both highly valuable commodities in the business world—go into extensive changes, which then create problems within a company as employees must adjust to a new system. To avoid the costs of redesign (and ironically, of improving quality), many corporate executives choose to preserve the status quo.[2] In some instances, when problems with a product arise, companies manufacture more new products in an attempt to fix or cover up design flaws.[3]

[2] Schriver 54

[3] *Information Anxiety* 122-124

A serious shortcoming of companies manufacturing products is the failure to test the usefulness of instructions in using a product. Many companies are required by law to perform safety tests on electronic devices, appliances, and other mechanical equipment, yet such strict regulations do not apply to the clarity of instructions. Impatient to distribute products to stores and into the hands of consumers, a number of companies hastily package products with instructions written from one perspective and stemming from one set of experiences—the engineer's. Consumers then face the difficulties of deciphering the engineer's language and technical illustrations. Analyzing how a variety of consumers use instructions to operate equipment would enable engineers, technical writers, and designers to see what difficulties arise. Redesign and revision of both products and instructions based on user input would lead to more "user-centered" design.[4]

[4] Schriver 443-473

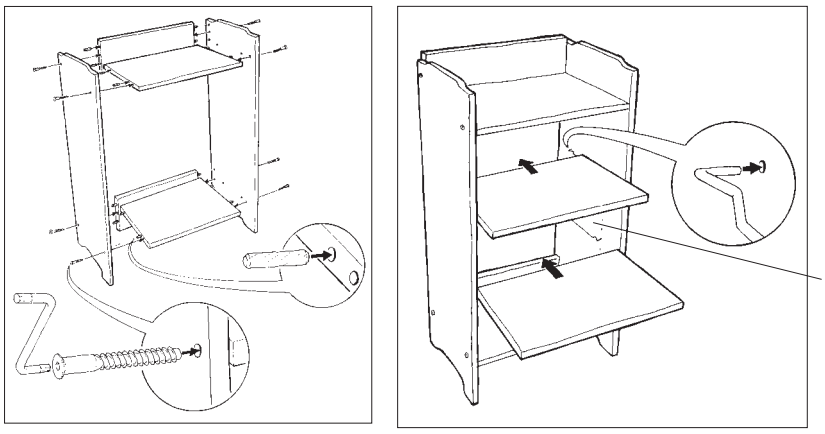


This diagram shows each participant in the information design process and the issues of concern to each. All are interlinked by way of the end user's abilities to process visual information and psychology or attitude regarding the information.

Examples of Ineffective Design

Mechanical

Although the line drawings appear accurate, the order of steps involved in constructing the bookshelf is not visible in the first picture.



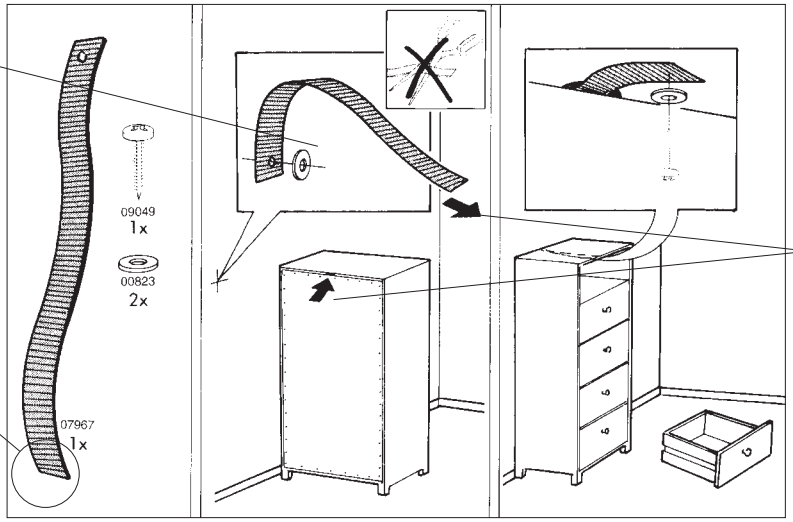
These instructions consist only of illustrations without text. Written directions might be useful to readers who are unsure of the correct assembly of the bookshelf without verbal explanation.

The second picture obscures the pieces of wire one needs to insert in the sides of the bookshelf in order to slide the shelves into place.

Assembly instructions for IKEA bookshelf

In the second panel, it is unclear what needs to be inserted into the wall. One can assume that the screw should be used, but only one screw comes with the device, and it appears in the last panel.

Both ends of the strip need to be fastened, and yet there is a hole missing on the bottom.

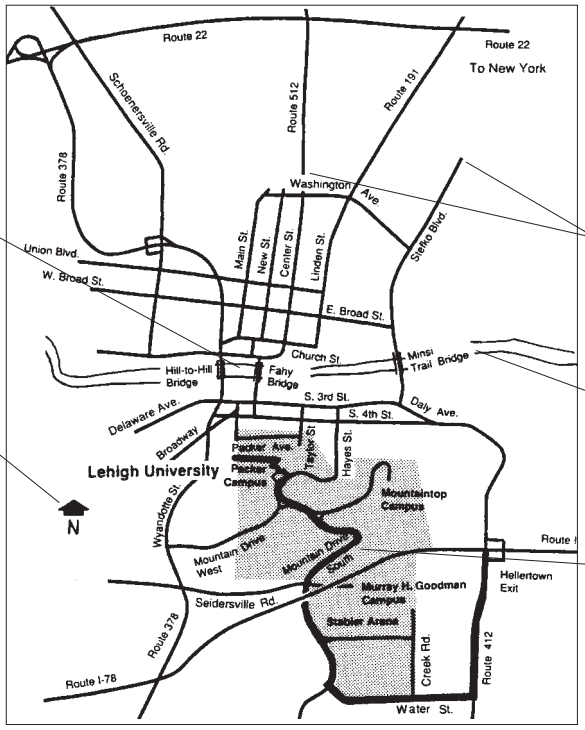


The anti-topple device is intended to keep tall or stacked furniture from tipping over, but these instructions only show how to affix one piece of furniture to a wall.

The role of the two heavy arrows is unclear. The top arrow suggests the reader pull the end of the strip, but the second arrow doesn't connect the previous action to complete the attachment of the strip to the furniture.

Installation instructions for Anti-topple Device by IKEA

Spatial



This map showing directions to Lehigh University purely relies on line and texture to show a geographic area.

This enclosed shape, bounded by two bridges and the lines indicating the Lehigh River, may be mistaken for a city block.

The streets and roads are unclearly indicated by the lines, which often break at labels and stop at arbitrary locations.

The Lehigh River, as depicted by a pair of thin lines, is broken up by text and bridges.

This arrow's compact shape and short length suggest a fixed point rather than direction.

Lehigh University is represented ineffectively by a large grey shape. Labels identify campuses, but there is no visual separation between them.

Directions to Lehigh University

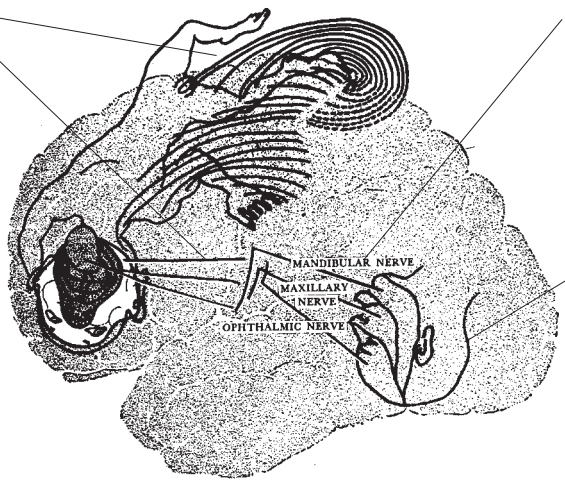
Too much information occupies this 1994 version of the PATH train map. It allows a macro/micro comparison of a region spanning more than 50 miles, even though the pertinent information for using the train is contained within a 10-mile radius (lower right section of map).

1994 Version of PATH Train Map

Cognitive

In this map of the brain and the parts of the body it controls, line and texture fail to effectively show forms. It is difficult to tell what body part is controlled by which area of the brain, particularly in the case of the curving lines radiating from the human figure.

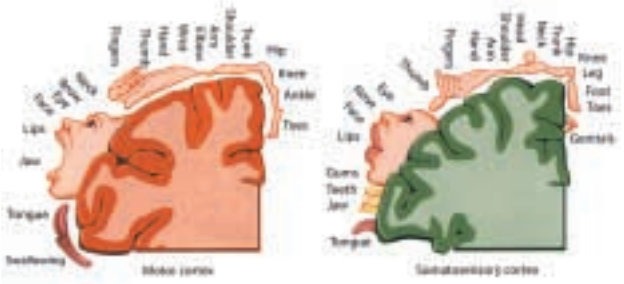
("From Stimulus to Symbol" 53, Originally appeared in *Neuroanatomy* by F.A. Metter, 1958)



The type is too small and hard to read against the textured background of the brain.

This head is disconnected from the human figure on the left side of the picture. Although lines and labels join the two parts of the image, their association is unclear.

Early Homunculus of the Brain



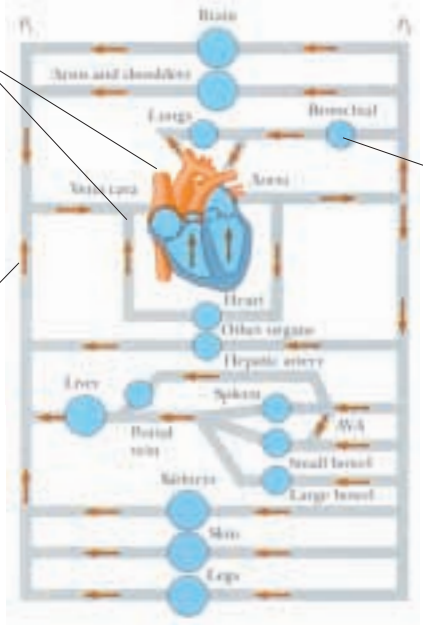
Newer, more accurate data regarding the brain's function and clearer connections between body parts and the brain make this version much more effective as a cognitive instructional aid.

(adapted from V.S. Ramachandran in Gazzaniga, Ivry, and Mangun 75)

Blood flow to and from the heart is overly schematized in this diagram. Major blood vessels and channels of the realistically-rendered heart do not correspond with the lines of blood flow.

(Serway and Faughn 294)

Arrows do not guide the reader smoothly through the system. None of the arrows follow corners where blood "turns." If the lines forming the network were arrows themselves, the direction of blood flow would be easier to see.



It is not apparent what blood does when it reaches organs. The blue color of the organ circles contrasts the warm blood color, which may suggest that the organs do not use blood but instead conduct it.

Diagram of Mammalian Circulatory System

6 Redesigned Instructional Materials

The following pages contain redesigned pieces from each category of instructional information:

- **mechanical information** — GBC Binding Machine Instructions
- **spatial information** — PATH Train Map
- **cognitive information** — Writing Center Punctuation Reference Sheets

Each redesign reflects the definition of purpose, understanding of content, imposition of structure, and design of visual and textual components. Discussions in the accompanying text detail specific adjustments or changes.

The last two steps in the information design process, evaluation and revision, relate to the original materials that I redesigned. My examination of graphical, functional, and psychological aspects of each document and my own experience informed my decisions to restructure and re-examine the configuration of graphic elements and visual variables. In all three original documents, structure is the weakest area while content is strongest. Design falls in between, as there are certain segments of content which are adequately represented by visual elements, such as the overhead perspective and major line colors in the PATH map; however, less appropriate distinctions or lack of distinctions, as in the original punctuation reference sheets, can interfere with the clarity of content.

With the completion of these newer versions of the instructional materials, analysis of their effectiveness through use and evaluation of success are necesssary to determine which areas (content, design, or structure) require improvement.

Mechanical Information: GBC Binding Machine Instructions

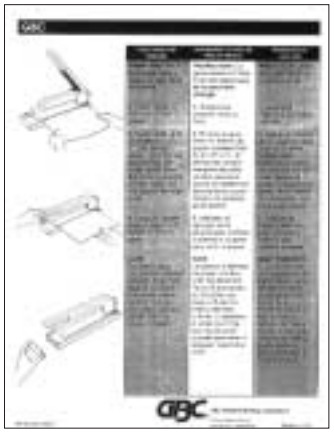
These instructions for a GBC manual binding machine (shown at 1/4 and 1/8 their original size) unsuccessfully combine line drawing and text.

Labels do not appear beside what they identify. Instead, an alphabetical key is used to connect the picture to a list of part names, forcing the reader to look back and forth between the two.

The illustrations are small and hide important detail in the binding area (left side of machine).

Text against a grey background is difficult to read because there is little contrast between black and grey.

Linespacing is too loose throughout the text. The space between lines of text in a procedure is about equal to the space between each step, thus running all of the actions in task together.



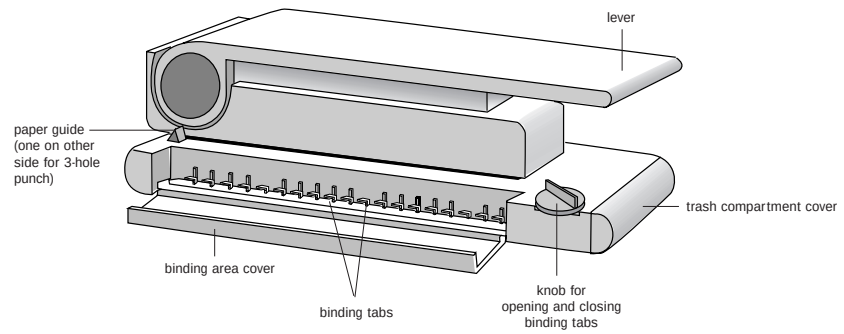
Redesigned Binding Machine instructions

In the original GBC binding machine instructions, which are seven pages long, text in English, German, French, and Spanish predominates each spread, or pair of pages. Illustrations are quite small and lack clear detail showing what occurs in each step of the binding process.

I have focused the text of my redesign on an English-speaking audience to cut down the number of pages in the instructions. The text is also more detailed at each step to guide the reader. The illustrations in the redesign are much larger to show the detail of the binding tabs and the binding spine. The reader can clearly see how the punched pages fit on the comb of the binding spine and how it closes to create a bound document.

Value helps indicate dimension of binding machine parts and the document being bound. Black sans serif type against a white background reads more easily than the original black on grey type. The three-quarter view and top view help familiarize the reader with the dimensions of the device and where controls are located.

Using the Binding Machine



To use slot punch for binding:

1 Adjust the paper guide to align the slots with the length of the paper. No slots should cut into the bottom of the pages.

2 Raise lever.

3 Insert paper into right side of machine, lining the top left corner of the page fully against the inside of machine.

Note: Do not insert more than 5 sheets of regular copy paper into either hole punch. When using heavier paper, punch one sheet at a time.

4 Lower lever to punch holes.

5 Raise lever to remove paper.

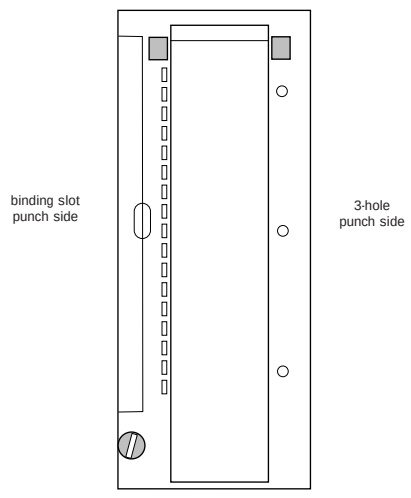
To use 3-hole punch:

Follow the same instructions as above, but insert paper into the right side of the machine.

To empty trash compartment:

Remove the trash compartment cover and shake out the paper punch from the machine over a trash bin.

If wads of paper are stuck inside, flip the machine over, remove the plastic cover nearest the wad with scissors, and extract the paper.



top view

Binding Machine instructions

To bind documents:

1 Be sure that the lever is lowered and that the plastic cover on the left of the machine is open, revealing the binding tabs.

2 Turn the knob counter-clockwise to close the tabs completely.

3 Using scissors, trim a plastic binding spine to the size of your document. Slide the binding spine securely onto the blue tabs with the curl of the prongs facing up.

4 Turn the knob clockwise to open the binding spine. The spine should be opened just enough to allow for loading of pages. If opened too wide, the prongs will snap off of their tabs.

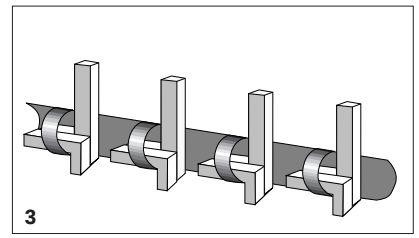
5 Place each page of your document onto the spine prongs, starting with the cover or first page face down. If the page size is uniform, you can load all of the sheets at once.

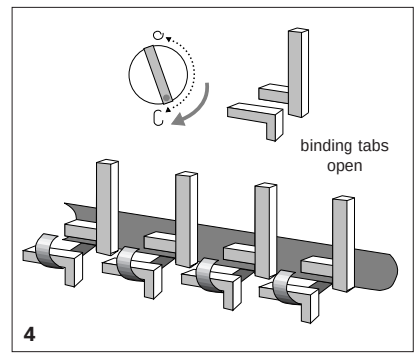
Note: The 1/4" spines take up to 25 sheets of regular copy paper.

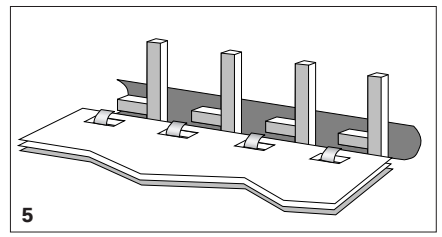
6 When you have placed all of the pages on the prongs, turn the knob clockwise to close the spine.

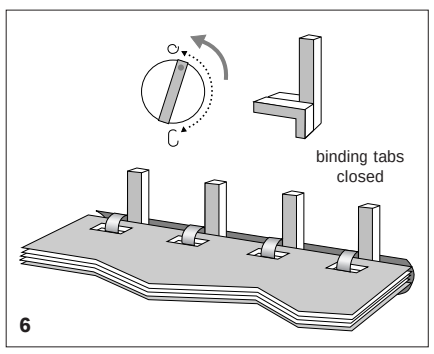
7 Carefully slide the document towards the paper guide and off of the tabs to remove.

If you have trouble removing your bound document from the tabs, make sure that you have turned the knob completely counterclockwise and that the tabs are shut. Firmly lift your document and guide it horizontally from side to side until the pages are freed from the tabs.









October 1998 PATH Train map

Two maps would more effectively show the difference in train service. Including another line to show off-peak and holiday service might lead one to think that the line is another train route that runs simultaneously with the others.

Lines for streets are too thin in comparison to the train lines. Such thin lines are better suited for rules, boundaries, and frames rather than streets

The small, condensed, and italicized type is very difficult to read.

The alternating box texture of the off-peak and weekend train line is confusing because the box shape and size is identical to that of the square individual stations.

Stops along the train routes appear beside the lines, and in a different color, leading the reader to think that they may be some other kind of feature.

The location of the World Trade Center on the map is misleading. One might think that the location is on Sixth Avenue, when it is on Church Street (labelled further below).

Redesigned PATH Train map

My redesign of the PATH train map incorporates some of the original elements while simplifying the amount of information in the design. As a frequent traveler on the PATH train, I have become very familiar with the system and the problems that arise from trying to use the map supplied by the Port Authority, which operates the PATH train.

The most common problem with using the map is knowing which line to take at a certain time. By separating the maps, I intended to eliminate the confusion of presenting the Journal Square to 33rd Street via Hoboken train as an additional line during regular or peak hours in the top map.

I preserved the intense colors of the train lines so that they would stand out against the subdued background colors. Also, the operating times on each map and the names of the terminals are bold to distinguish their importance from other pieces of information.

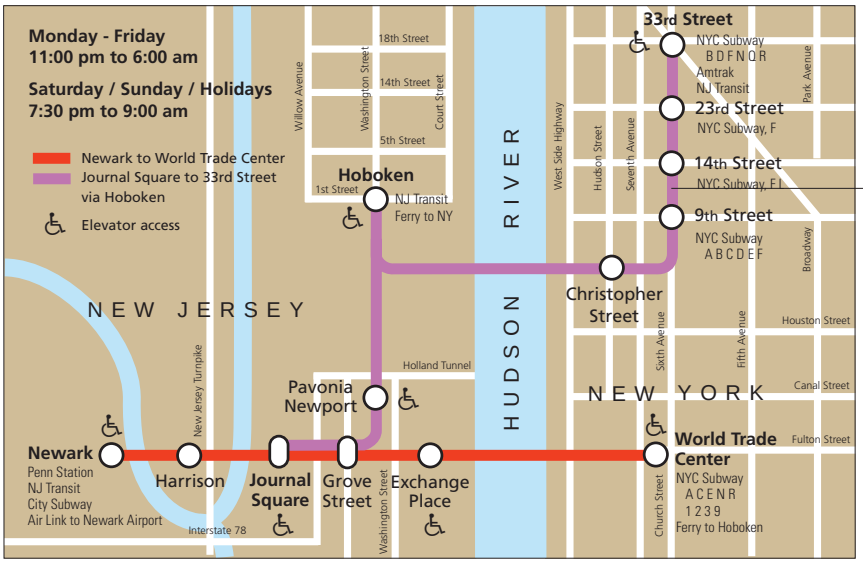
This body of water wrapping around Harrison is missing from the current PATH map. It is a prominent geographical feature which could help to orient a traveller.

Stations are circular for single lines and oval for stops shared by two lines. These shapes appear on the lines instead of beside them and are more pleasing to the eye.

For labels, I used a clearer typeface—Frutiger— which is neither condensed nor italicized. The only variation in type weight is between regular and bold weight.

I used Univers condensed regular for the connecting transportation lines. Univers condensed accommodates plenty of information in a small space.

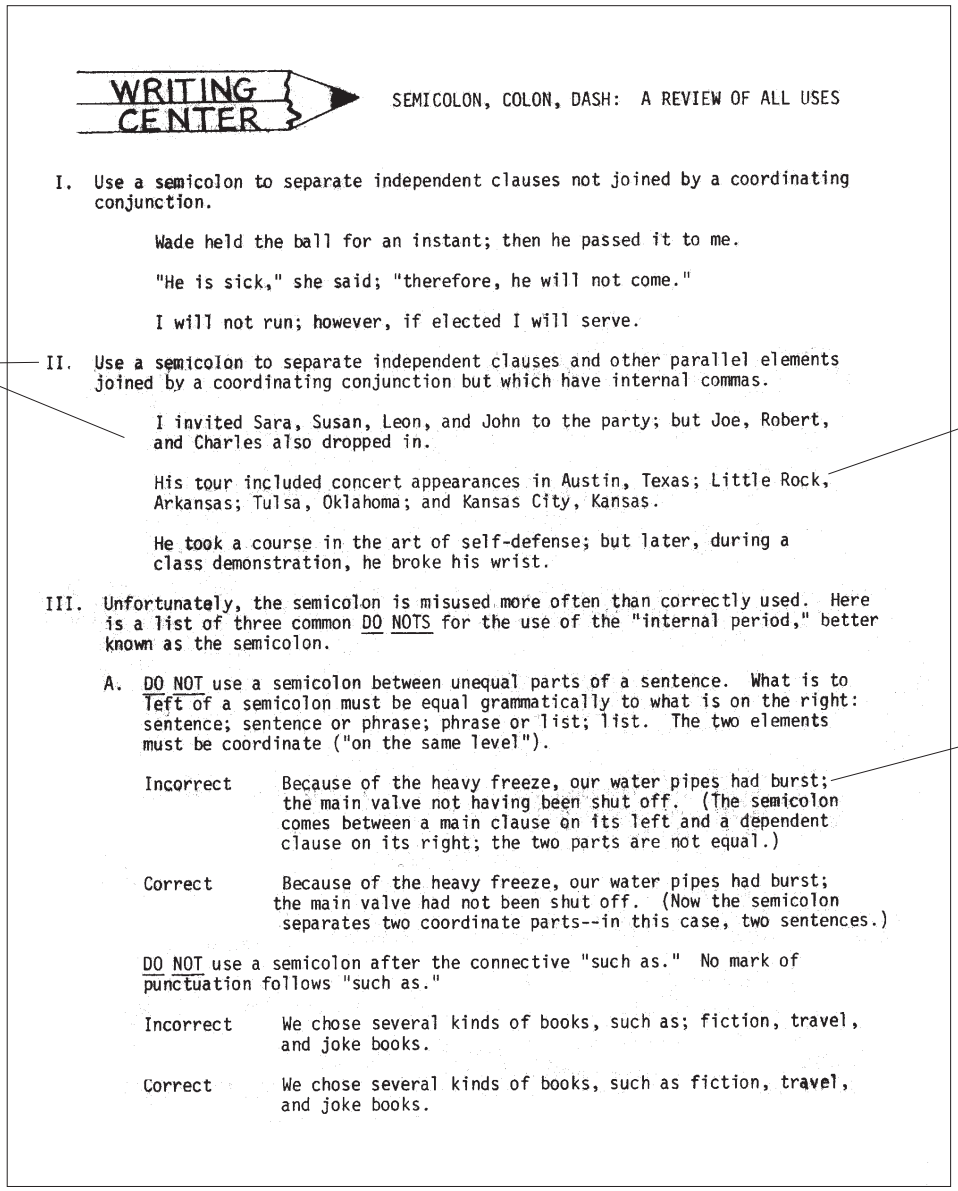
Two maps show two separate realities in time, providing a more accurate depiction of the train service over time.



Instead of using a textured line, I added another color which signifies different service while covering the same path as the line in the original map.

Cognitive Information: Writing Center Punctuation Reference Sheets

This page from a packet on semicolon, colon, and dash use (shown at more than 1/2 of the original size) represents the standard format for all punctuation reference sheets in the Writing Center.



WRITING CENTER

SEMICOLON, COLON, DASH: A REVIEW OF ALL USES

I. Use a semicolon to separate independent clauses not joined by a coordinating conjunction.

Wade held the ball for an instant; then he passed it to me.

"He is sick," she said; "therefore, he will not come."

I will not run; however, if elected I will serve.

II. Use a semicolon to separate independent clauses and other parallel elements joined by a coordinating conjunction but which have internal commas.

I invited Sara, Susan, Leon, and John to the party; but Joe, Robert, and Charles also dropped in.

His tour included concert appearances in Austin, Texas; Little Rock, Arkansas; Tulsa, Oklahoma; and Kansas City, Kansas.

He took a course in the art of self-defense; but later, during a class demonstration, he broke his wrist.

III. Unfortunately, the semicolon is misused more often than correctly used. Here is a list of three common DO NOTS for the use of the "internal period," better known as the semicolon.

A. DO NOT use a semicolon between unequal parts of a sentence. What is to left of a semicolon must be equal grammatically to what is on the right: sentence; sentence or phrase; phrase or list; list. The two elements must be coordinate ("on the same level").

Incorrect — Because of the heavy freeze, our water pipes had burst; the main valve not having been shut off. (The semicolon comes between a main clause on its left and a dependent clause on its right; the two parts are not equal.)

Correct — Because of the heavy freeze, our water pipes had burst; the main valve had not been shut off. (Now the semicolon separates two coordinate parts--in this case, two sentences.)

DO NOT use a semicolon after the connective "such as." No mark of punctuation follows "such as."

Incorrect — We chose several kinds of books, such as; fiction, travel, and joke books.

Correct — We chose several kinds of books, such as fiction, travel, and joke books.

Roman numerals and indentations help break up the text into categories and examples. However, variations in type weight and style which would help emphasize the placement of the punctuation marks, such as bolding or italicization, are not present.

The typewritten text is "monospaced," having equal space between every character. This creates "rivers," or distracting spaces between letters in lines of type.

There is no form of visual distinction for the punctuation marks in each example.

Page from Origninal Writing Center Punctuation Reference Sheet on Semicolon, Colon, and Dash Use

As a tutor at the Writing Center, I found that grammar and punctuation reference sheets such as this one were rarely used in tutoring sessions. The guidance of tutors combined with consultation of *The Bedford Handbook for Writers* by Diana Hacker seemed to meet the needs of clients.

However, outside of tutoring sessions, some students require additional reinforcement of what they learned in their tutoring session, especially with regard to punctuation rules. The available reference sheets had not been revised since they were created in the early 1980s; consequently, their appearance is off-putting to students who are accustomed to more lively, modern-looking materials (such as new, colorful editions of standard textbooks).

In redesigning the punctuation reference sheets, I sought to consolidate lessons and examples on the common punctuation marks: comma, colon, semicolon, hyphen, dash, period, question mark, exclamation point, single quotation marks, double quotation marks, points of ellipsis, parenthesis, and brackets.

Rather than simply "reinvent the wheel" and copy the format used in popular grammar texts, I experimented with more striking, bold, and creative designs that would help enhance students' memory of usage rules. I adapted text from *The Bedford Handbook for Writers*, created my own examples, and emphasized important functions of each mark visually.

Redesigns of Writing Center Punctuation Reference Sheets

hyphen

- Use to **connect** two or more words functioning together as a single adjective before a noun.

half-baked scheme
devil-may-care attitude
well-groomed appearance

- Hyphenate the written form of **fractions** (two-thirds, one-half) and of compound numbers from twenty-one to ninety-nine.

- Use to **avoid ambiguity** or to separate awkward double or triple letters.

under-recognized

- **Divide** words with more than two syllables at the end of a line. Hyphenate the words **between syllables**, but avoid cutting off single syllables.

Explanation text contrasts example text in weight and size: examples stand out more prominently since they readily demonstrate usage than the written rule.

Jane's
it is = it's
don't

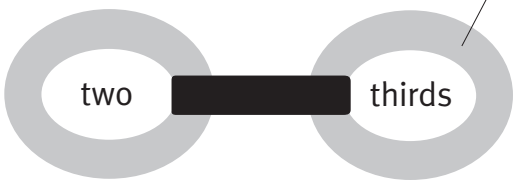
For the apostrophe I drew upon its actual placement in text, while for the hyphen, I used diagrammatic example. This difference in presentation helps emphasize the marks' distinctness from each other.

apostrophe

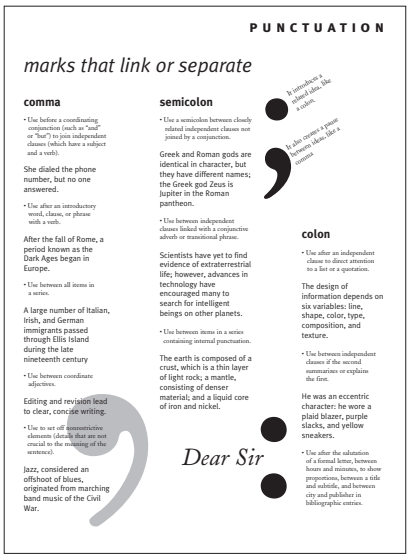
- Use to indicate that a noun is **possessive**.

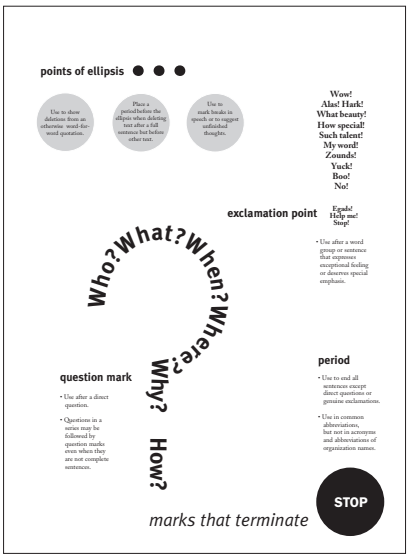
- Use an apostrophe and -s to indicate that an indefinite pronoun is **possessive**. An exception is the word "its," which does not require an apostrophe unless it is a contraction of "it is."

- Use an apostrophe when forming **contractions** of words paired with "will," "not" and "have."



The arrangement of elements on each page is playful and active so as to engage the interest of students who are accustomed to the ordinariness of dull gray blocks of type. Each mark has a striking shape which provides contrast and variation.





Conclusion

We are racing forward into cyberspace without having recognized the need for clear print communications. The present shortcomings of two-dimensional information are being carried over into the digital realm, where the capability to disseminate ideas to larger audiences is still undeveloped. Carelessly written text and confusing icons clutter the computer screen; hyperlinks lead the way to more fragmented information contained in a maze of pages. Vast electronic storehouses of online data are compartmentalized according to overly specific keywords when accessed through different search engines; once one types the "correct" keyword, one must then navigate through the hundreds, thousands, or even millions of locations where the needed information may reside. Many websites employ user interfaces rife with distracting animation, camouflage backgrounds, and appearing and disappearing text. Access becomes reduced to the level of hide-and-seek; the time one spends searching for information as well as the amount of space that information occupies are too often wasted.

Computer technology is a powerful tool for shaping and transmitting information, yet it easily creates a chasm between user and information when its purpose, content, structure, and design fail. Often, self-interest, a weak understanding of content, arbitrary organization, and a limited visual vocabulary result in thin substance with little value. The relative ease with which one can upload words, pictures, sounds, and movies leads to a neglect of process in favor of instant gratification, the satisfaction of seeing one's "work" on a computer screen.

Understanding the process and principles of information design is crucial to the productive development of information technology. Knowing how to use new technology must parallel the solid grasp of visual design principles. A sensitivity to the intricate relationships of ideas and images builds an awareness of thought structures which one can apply to multimedia design. New forms of instruction characterized by the interplay of sound, animation, and text demand heightened skill in synthesizing diverse amounts of data which succeed not only as virtual realities of sensory stimulation, but also as usable information.

Effective information design does not result from isolated experience but from collaboration among all participants in the information design process. Communication among professionals from business and industry, science, government, and design would help improve the understanding of design concepts and bring them into everyday practice. Contact with consumers and users of information would lead to more appropriate ways of presenting information through evaluation and revision of products and instructional materials. The exchange of knowledge borne from successes and failures would advance the practice of information design by promoting innovation and newer understanding.

While universal understanding is yet an unattainable ideal, the purpose of an information designer remains grounded in serving basic human needs: truthful, meaningful, effective, and dependable information that fosters personal growth, affirms an audience's intellectual capabilities, and, perhaps, sparks a curiosity for learning.

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