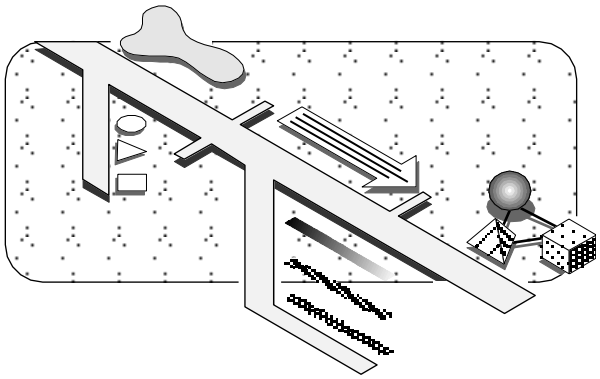
DRAFT

Language of graphics



This chapter is both the simplest and most advanced in this book. It takes you "back to basics." It explores the fundamental elements and characteristics of graphics and shows how they combine to communicate specific kinds of messages. Understanding such fundamentals enables you to extend standard graphical forms and even create entirely new ones.

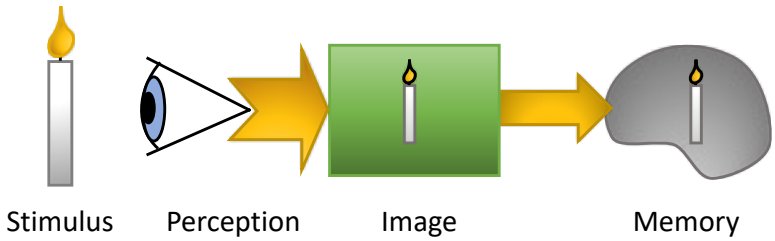
HOW PEOPLE PROCESS VISUAL IMAGES

Understanding how people process visual images is important because images demand more of our visual perception. It is also important because a naive understanding can lead to poor images. Understanding visual perception enables us to design in such a way as to take advantage of how that perception system works.

And, if you understand how graphics work, you understand how we communicate—regardless of medium.

Naive model of visual processing

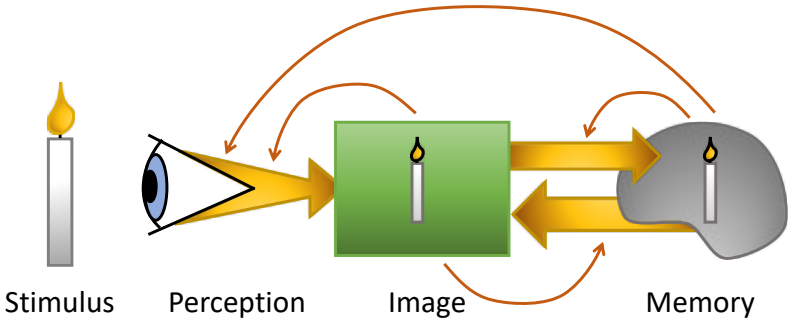
The naive designer conceives of human vision as something like a not-so-smart camera. Perception forms an interior image that replicates exactly the scene in front of the eyes. This scene is photographically recorded and filed in memory.



This is a simple, intuitive model, but it is wrong. If it were true, we could only recognize objects that look exactly the same as they did the first time we encountered them.

Richer model of visual processing

A more realistic model shows how everything in the visual system seems to affect everything else:



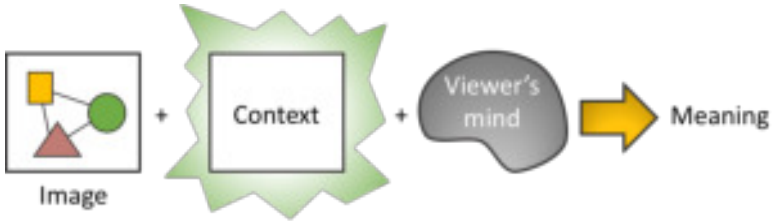
The differences between this and the naive model are important:

- Perception filters visual inputs. Less than 1/1000 of 1 percent of the information taken in by the retina makes it through short-term memory.
- We remember not just one visual image for the object but several.
- In additional to visual memories, we remember the name of the object and its characteristics. All these memories are linked so that recall of one can trigger others.
- Much, perhaps most, of what we see comes not from the eyes but from memory. We see mostly what we already know and have seen before. Visual input seems designed more to trigger the correct memories than to tell us directly what something looks like.
- What we currently see and what we have seen affect how we interpret visual input and what we remember. We tend to seek out details that confirm our current interpretation of a scene.
- Imagination can fill in gaps left by perception and memory. We see what the mind says we should see.

It is a more complex model and it is messy. Everything affects everything else. This is why designing an effective image is so difficult.

WHERE DOES MEANING COME FROM?

Images alone are meaningless. An image in a particular context, however, triggers memories and associations in a viewer's mind that produce what we refer to as the meaning of the image. Only in a particular context and interpreted by a human mind does the image have any meaning.



We are accustomed to thinking of the image as the conveyor of an idea or concept. We talk as if meaning were inherent in the image. However, the image is more like a catalyst that releases meaning in the presence of a context and a human mind.

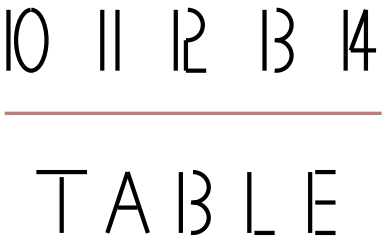
Context contributes to meaning

The context is the situation in which we view the image. It consists of all the other things in the field of view that add to or interfere with the image. We can think of context as all the hints that nudge us toward one particular interpretation of an image.

Context can be supplied by:

- Adjacent images
- Related labels or other text
- Other displays
- Other objects in the environment

Let's see how context affects our interpretation of visual images. Quickly read the following two lines:



Most people read the top line as "eleven, twelve, thirteen, fourteen, fifteen" and the bottom one as "table," without noticing that the number "13" is identical to the letter "B."

In this example, notice how the following visual symbols achieve different meanings in different contexts:

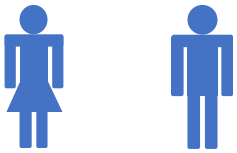
Symbol	Context	Meaning
	Hallway door	Women's restroom
	Hospital	Gynecology
	Movie theater	Projection room
	Computer animation program	Show animation
	Highway sign	Restaurant
	Restaurant menu	Beverages
	Grocery store in the United States	Coffee
	Grocery store in the United Kingdom	Tea

Consider the different meanings of these common symbols often found in images:

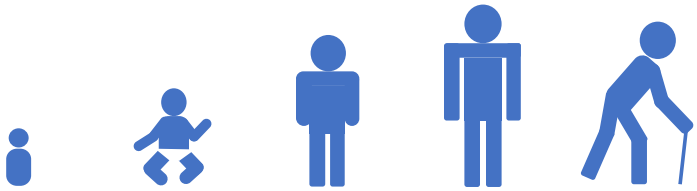
This symbol …	… in this context …	… means this
?	Menu bar	Help facility
	Fill-in-the-blanks form	Missing information
	Flowchart	To decide
	Equation	Variable to solve for
Arrow	Connecting blocks in a diagram	Movement in organizational structure
	Scroll bars	Direction the viewer's viewpoint will appear to move
	Flowchart	Flow of data or control
	Ruler of a word-processing program	Mark of a point, for example, a tab stop
Color red	Traffic light	Stop
	Weather map	Hot
	Anatomical diagram	Arterial blood flow
	Security	Danger

Often the strongest context is provided by adjacent images. For example, the meaning of this image by itself is ambiguous:

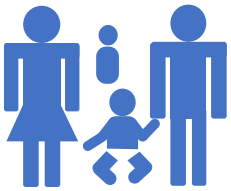
In one of its most common pairing, it represents a gender:



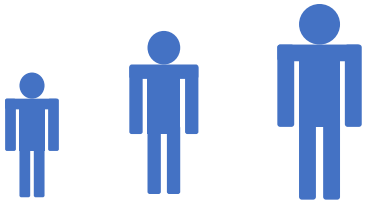
In this group of images, however, it represents a stage of life:



In this one, it represents one member of a traditional family:



Here it is merely a familiar object used to represent a size:



Without knowing the context in which an image will be seen, we cannot say how viewers will interpret an image. The context can reinforce or totally reverse our intended meaning.

Context also includes information about the image or the scene shown in it—information that helps interpret the image. Such information is sometimes metadata, that is data about data, the first data being context and the second the image.

Context can include the classic 5Ws + H:

What	What is shown?	What is it called? What is its official designation or model? Is it different from others of its class?

Where	Where is it?	Where is the scene depicted in the image? In what environment does it occur?
When	When was it created?	What specific moment does it record? What is the age of the object shown?
Who	Who made it?	Who conceived and executed the image? What organization or person sponsored and published it?
Why	Why was it made?	What prompted creation of the image? What is the viewer supposed to do in response to this image?
How	How was it made?	What devices, techniques, and materials were used?

The viewer's mind completes meaning

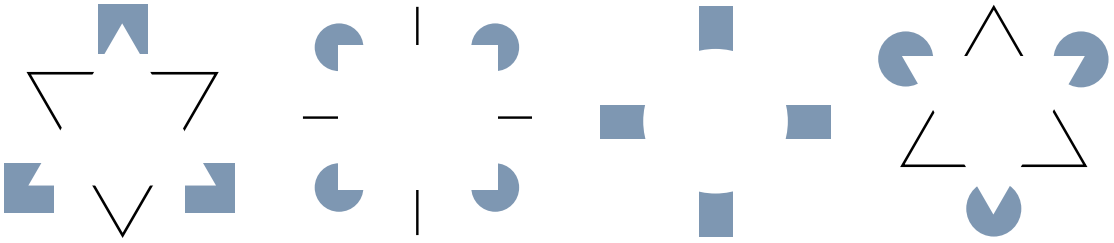
The image in a particular context triggers mental processes that lead to the meaning. That meaning depends on the mental processes of the viewer.

- Perception filters inputs
- Interest and curiosity guide attention
- Memories and knowledge fill in blanks
- Reasoning interprets and infers
- Emotion motivates and energizes
- Imagination extends
- Biases and expectations block or select

Perception filters inputs

Human perception is a ruthless, purposeful filter. Only about 1/1000th of 1 percent of the information taken in by the eyes survives our short-term memory. This filtration not only saves us from being overwhelmed with raw data, it actively seeks out and presents simple patterns to us. Instead of 300 million dots of light, we see meaningful objects and patterns.

Do you see the white triangles, square, and circle in these figures?



Where did they come from? Your mind constructed them by inferring simple patterns to fit the visual input.

Interest and curiosity guide attention

We see what we notice, and we notice what we are interested in. If you flip through the pages of a magazine, you are more likely to notice advertisements for food if you have not eaten in several hours than if you have just consumed a filling meal.

Memories and knowledge fill in blanks

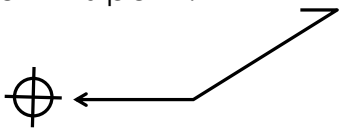
We need little visual inputs to recognize familiar objects. For example, what are these two objects?

Even though you had only a few shapes, you probably recognized a violin (or bass or cello) and a camel (or horse). Once you know what the object is, your memory can fill in all the necessary details.

Reasoning interprets and infers

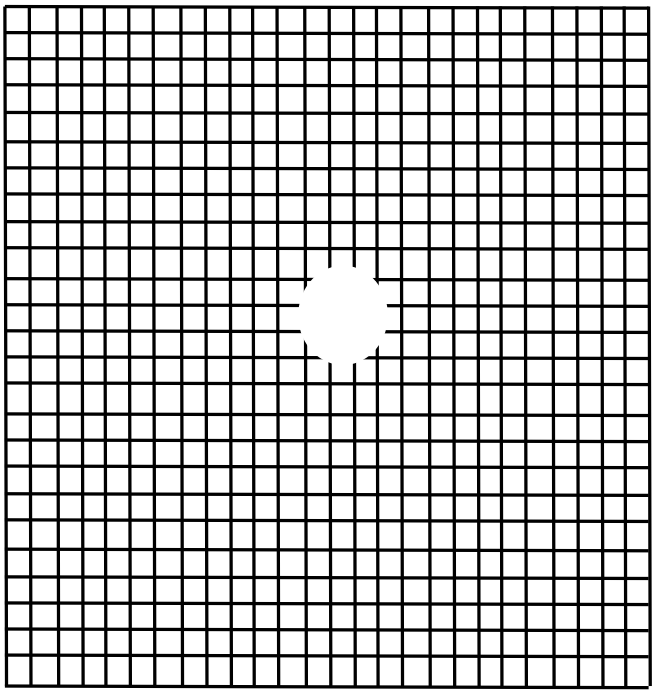
Consciously and unconsciously we reason about what we see. Using visual input as a starting point we make inferences about what produced the input. Try this exercise:

Close your left eye and fix your right eye on this point.



Adjust the distance of the page until the white circle at the right disappears.

What takes its place?



The white circle disappears because at a certain distance its image falls over the blind spot of the right eye, where the optic nerve joins the retina. When the white circle disappeared, what took its place? A continuous grid, right? Where did the rest of the grid come from? It came from a reasoning process that made the missing part of the image consistent with the rest of the image. Unconscious reasoning processes make the reasonable assumption that the missing part is just like the surrounding area.

One image can have multiple meanings

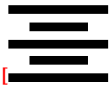
Each image has a matrix of possible meanings depending on contexts and viewers. The simple equation …

$$image_i + context_j + viewer_k \rightarrow meaning_{ijk}$$

… has great implications for us as designers.

An example of meaning depending on context and mind

What does this image mean?



The answer depends on where it appears and on who is looking.

Shown alone, its meaning depends on the previous associations of the viewer. An electrical engineer is likely to interpret it as the symbol for battery. A writer is likely to interpret it as centering lines of text. Others may interpret it as an emblem for symmetry, elaborate sandwiches, or some other concept.

When shown in the company of related images, the meaning of centered lines becomes clear to most viewers, regardless of previous associations.

The effect of context overrides previously learned associations to suggest a new meaning.

Restrict the context

If the meaning varies with context, the symbol is context dependent. That is …

$$meaning_{I1K} \; != \; meaning_{I2K}$$

In this case we must control the context in which the image appears. We must consider what other items are visible at the same time as the image and what events lead up to its display. We must then control these so that the appearance of the image suggests just the meaning intended.

Test with actual viewers

If the meaning varies with viewer, it is unclear. That is …

$$\text{meaning}_{IJ1} \mathrel{!}= \text{meaning}_{IJ2}$$

Images that depend on specific professional or cultural knowledge are likely to fail for members of another profession or culture. The only way to know whether your images are clear is to test with actual viewers under realistic conditions.

Avoid ambiguous images

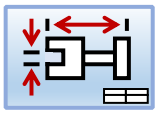
If multiple meanings are possible in a single context by one viewer, the image is ambiguous. That is …

$$\text{image} + \text{context}_j + \text{viewer}_k \rightarrow \text{meaning}_1 + \text{meaning}_2 + \text{meaning}_3$$

In this case, the viewer cannot figure out the meaning of the image or is unsure about which of the possible meanings to believe.

Anticipate the mind of the viewer

Rather than starting with the design of the image, we must start at the other end with the knowledge and mental processes of the viewer. We must ask ourselves what symbols, objects, and concepts are already familiar to the viewer. These may vary from one group of viewers to another:

Concept	For office workers	For engineers
Measure		
Draw		
Document		

Don't design standalone symbols

Conventional wisdom—or at least the viewer-interface style guides for several large computer or device manufacturers—insists that you should make icons completely meaningful regardless of context or viewer. Such a naive approach is both impossible and unwise.

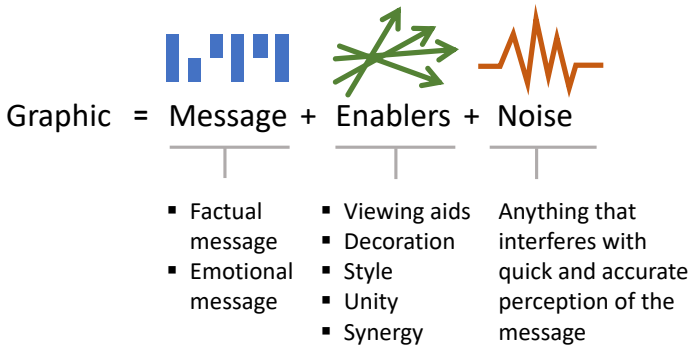
Don't design images to stand alone. An image, like a word, achieves meaning only by its use in a particular context. Trying to make an image completely unambiguous to everyone under all possible circumstances is usually impossible in most cases. Attempting such a feat leads to overly complex designs. Instead, design the image so that under actual viewing conditions it combines with other information in the viewer's field of view and working memory to produce a clear meaning.

HOW DOES THE VIEWER REACT TO THE IMAGE?

So far we have been looking from the inside out. We have been looking at what the designer does to encode meaning in the image. We must now turn and look at the image through the eyes of the viewer. We must turn from discussing what the designer puts into the image to what the viewer gets out of it. Our model needs a little elaboration:

image + context + mind ➔ message + enablers + noise

Every pixel contributes either message, enabler, or noise. The *message* is what you are trying to say. It is the concept you are trying to represent or the emotion you want to trigger. The *enablers* help the viewer get the message reliably and accurately. *Noise* interferes with that process.



The message

The message is what the image is all about. If the viewer recognizes the image as representing the concept you intended, the message is understood.

There are two kinds of messages: factual and emotional. Factual messages represent specific information. They are ideas or concepts that we want the viewer to recognize intellectually. Emotional messages are feelings we want the viewer to recognize and perhaps experience. We might want the viewer to feel motivated to use the product, concerned about dangers, and happy with results.

Enablers

Enablers are not part of the message, but they may be essential to speedy, reliable delivery of the message. Enablers help the viewer interpret the message. The easiest way to think of enablers is

to imagine what would happen if they were omitted. If you leave out enablers, viewers can still get the same message, but it will take them longer and they will make more mistakes.

One of the strongest enablers is redundancy. **Redundancy** means saying the same thing more than one way, such as signaling caution by a triangular shape and yellow color. Redundancy is not waste; it adds predictability. It resists misinterpretation and accommodates busy, varied, sometimes imperfect viewers. It is absolutely necessary in communication. In fact, English prose is about 75 percent redundant.

Messages may be communicated redundantly. That is, the same message may be encoded in two different ways in the same image. Consider the stop sign, a red octagon labeled with the word "STOP." We could take away the word "STOP" and most people would still interpret the message in the same way. Thus, we can say that the message was redundantly encoded with text, with color, and with shape. Redundant encoding is quite common where messages are critical or where conditions work against one encoding method. Those who cannot read the word "STOP" or those who are color blind could still get the message.

Another enabler is decoration that invites the viewer to notice and study the image. **Decoration** draws the eye to the graphic. If decoration does not get in the way of meaning, it can be useful, motivating the reader to study the graphic in detail. Decorative aspects further the purposes of the graphic but do not represent information directly.

More enablers include:

- Backgrounds that make the subject stand out clearly
- Consistent style that highlights differences between the images of a series
- Borders, guidelines, and alignments of objects that guide the eye to the true subject of the image

Anything that improves the efficiency and reliability of an image is an enabler.

Noise

In any form of communication, noise is bad. **Noise** is anything that interferes with the sure delivery of the right message. Noise is simply poor design.

Anything that is not clearly enabler or message is probably noise. Noise is relatively easy to detect. If you suspect that something is noise, simply remove it and observe what happens. If viewers get the same message more quickly and reliably than before, then whatever you removed was noise.

Noise includes anything that distracts or misleads the viewer. It creeps in at every stage of design. Perhaps it is an irrelevant color or an object that triggers the wrong associations. Maybe it is a lack of foreground-to-background contrast. Often it is a decorative flourish that overwhelms the subtle message of the image.

So, which is it?

These components are highly interrelated. Enablers are necessary to overcome noise and to accommodate less than perfect viewers. The less noise there is, the less enabling is required. Decorative elements that fail become noise. To gauge the decorative component of an illustration, identify features not strictly necessary to communicate factual information. For instance, if a component is drawn larger or in more detail than necessary, these features are either decorative or they are noise.

Whether a component is message, enabler, or noise depends also on the knowledge, goals, and interest of the viewer. A knowledgeable viewer may be annoyed or distracted by redundant elements. Likewise, decorative elements may actually hinder a highly motivated reader.

Consider a circuit diagram. In such a diagram, different types of components are identified by different shapes. Such shapes convey meaning. If the diagram also uses color to reinforce the distinctions among components, the use of color is redundant. However, if colors were assigned, not to reinforce the shape codes, but merely to make the graphic more visually attractive, then the use of color would be decorative. If the diagram has a frilly border, that border is decoration. If the diagram is cluttered with many small notes of no interest to the viewer, then such notes are noise. If colors were assigned randomly, then they too would be noise.

What are we designers to do?

As designers everything we do contributes to the message, to enablers, or to noise. Often it is not easy to know which. A choice of color or selection of an object can create message, enabler, or noise. The only way to be sure is to test with actual viewers under realistic circumstances. Here is how you would analyze the test data:

If you take out the suspicious item and this happens …	**The thing you removed was this…**
Viewers get the intended message more quickly and more reliably	Noise
Viewers get the message, but take longer and make more mistakes	Enabler
Some viewers get the message, others do not	Redundant message
No viewers get the message	Nonredundant message

As designers, our job is to convey messages. To do that we must encode the messages clearly, include enablers for reliability, and eliminate noise.

- Encode critical messages redundantly, that is, use more than one method to represent each idea.
- Add enablers only if testing shows that they improve the speed and reliability with which viewers interpret the message.
- Unless testing shows something is message or enabler, leave it out because it is noise.

GRAPHICAL LANGUAGES

Since the 1600s when Leibnitz proposed developing a universal language of visual symbols that could be combined and read with the precision and logic of mathematics, many graphical languages have been proposed. These have included Charles Bliss's Semantography, Christopher Alexander's Pattern Language, Otto Neurath's ISOTYPE (International System Of TYpographic Picture Education), Yukio Ota's LoCos, Tom Zavalani's Jet Era Glyphs, and Picto by Jansen. Although these graphical languages have achieved limited success in specific disciplines, none have come to rival spoken or written languages. Nor do they encompass the many forms of graphics we use daily.

In this chapter I do not propose a new language but attempt to show how the many graphical forms achieve meaning and how we consciously and unconsciously use them. I treat graphics as a language, but as a language very different from English, French, or Chinese.

Though visual language has analogies with traditional literary rhetoric, an exact correspondence is unlikely. The human mind processes visual information in fundamentally different ways from how it handles heard or read words. Visual grammar is not like verbal grammar. The two do not share common parts of speech, syntax, and rules.

Imagine a language with only concrete nouns and adjectives—no verbs, no abstract nouns, no adverbs. Thus, to convert a verbal expression to graphics, we must convert all verbs, abstract nouns, and adverbs to concrete nouns and adjectives. In graphics, we must represent tense, active and passive voice, and abstraction indirectly—by visual metaphor.

On a scale of directness, we can show:

- Objects (concrete nouns)
- Characteristics of objects (adjectives)
- Relationships between objects (adjectives)
- Change (state of being or passive verbs)
- Action on or by objects (action verbs)
- Abstract concepts (abstract nouns)

THE BACKDROP SETS THE STAGE

The background and frame of the graphic help define its scope and provide a frame of reference for interpreting the graphical objects contained in the graphic.

The background is the part of the graphic we don't notice consciously. It identifies the scope of the graphic and establishes a frame of reference against which the graphical objects are measured. It consists of:

- Frame or border around the entire graphic or graphical objects
- Background surface upon which the graphical objects are arranged

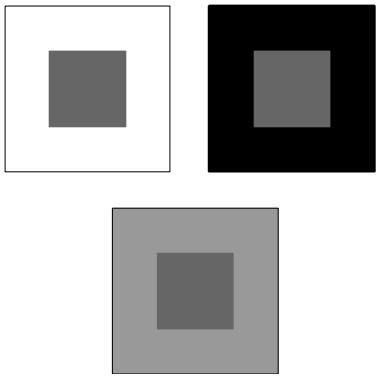
Often the background is simply blank space.

Background

There is a tendency to think of the background as simply empty space; in other words, just what's left over after the graphical objects are drawn. Such thinking defeats the two clear purposes of the background: to provide a baseline reference for graphical objects and to separate and organize those elements.

The human perceptual system is poor at making absolute judgments of color, size, lightness, or other graphical characteristics. It does, however, make effective comparisons between nearby images. The background of the graphic thus sets the reference level against which graphical objects are evaluated. A white background will make gray objects appear darker while a black background will make them appear lighter. A background that too closely matches the characteristics of an object will swallow and hide that object.

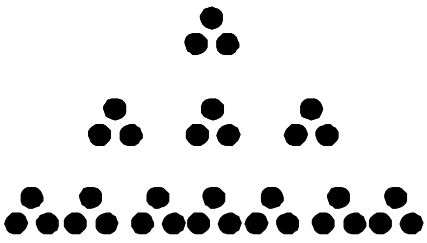
Background is basis for comparison



It may seem odd to think of blank space as a graphical force. But, blank space is not nothingness, not just what's left over, not insulation to keep ideas from touching. It isolates individual forms and shepherds the viewer's eyes about the design in a predictable path. Blank space can communicate. Using blank space actively, between and among objects, can signal:

- Relative importance of objects—put more blank space around more important objects.
- Groupings of objects—place related objects close together and unrelated ones farther apart.
- Interrelationships among objects.

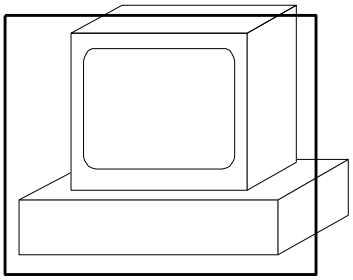
Blank space shows relationships



Frame

The frame of a graphic is the limit of the graphic within the viewer's field of view. The frame, visible or implied, is not a passive decorative feature. The frame isolates the enclosed area from its environment and places its contents "on show". It affects the balance, force, relative importance, and weight of graphical objects within the frame and imposes order upon them. It provides psychological security to viewers. The frame shows the limits of the visual symbology. If the subject extends to the frame, it is perceived as continuing beyond the borders of the illustration.

Frame directs view



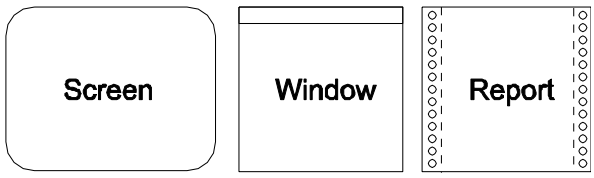
Should you put explicit borders around graphics? Many designs include a rectangular border to clearly show the extent of the figure. Others dispense with the border and let the margins and edges of surrounding text define the frame of the graphics. Still others integrate text and graphics in such a way that text flows tightly around the graphic, giving the graphic an irregular outline.

Reasons to box graphics	**Reasons to avoid boxes around graphics**
Some research suggests that viewers refer to boxed graphics more quickly and more often than unboxed ones (255).	A reluctance to cross borders may cause some readers to detour around boxed graphics.
The shape and style of the box can designate the type of information contained in the graphic.	Because the subject cannot extend all the way to the border, borders waste space.
Graphics that contain text, such as images of computer screens, can be placed closer to body text without confusion.	

You can make the border a meaningful part of the graphic by using it to reinforce and clarify the message of the graphic:

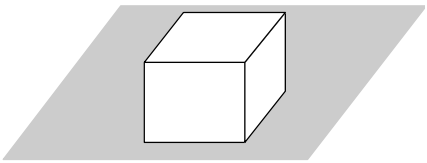
- Make the border of computer screens rounded like the screen itself.

Border sets context



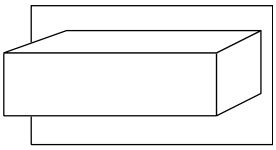
- When showing reports, forms, screens, and windows, style the border of the graphic to resemble the border of the object shown.
- Show three-dimensional objects in a diamond or trapezoidal frame. The edges of the frame should converge toward imaginary vanishing points.

Border adds depth



- To enhance the three-dimensionality of an object, let it protrude out and over the frame of the illustration.

Violated border adds depth

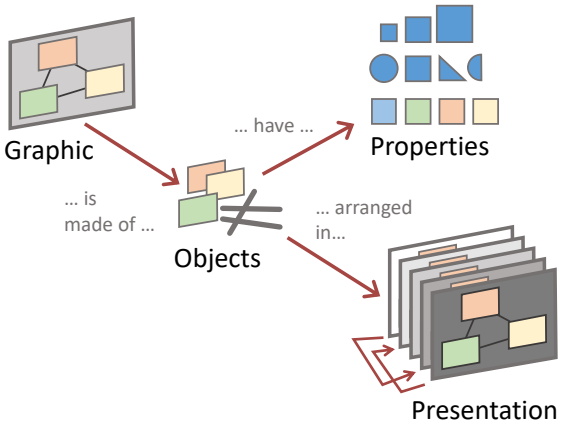


WHAT CAN WE USE TO ENCODE MEANING?

What resources do we as designers have to encode meaning in a graphic? What can we use to control the context in a way that suggests the desired meaning in the mind of the viewer?

Graphics can include objects, properties, and presentations

We can think of a graphic as composed of three bearers of information: objects, properties, and presentations.



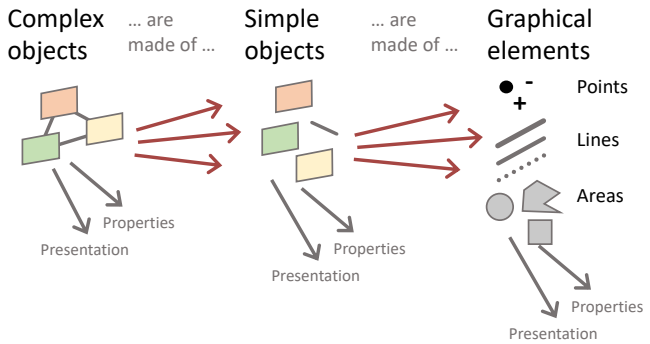
Objects are simply the "things" we see in a graphic. They are the nouns of our graphical language. The properties are the visual characteristics of the objects. They are the adjectives. The

presentation concerns the arrangement of objects in space and over time. The presentation is the syntax of our language.

Choices of objects, properties, and presentations encode meaning into the image.

Objects are made of simpler objects and elements

Objects are the subject matter of the graphic. Anything we notice as a separate entity is an object. Objects can be simple or complex. Complex objects can usually be decomposed into simpler objects. These simpler objects can be decomposed until eventually we are left with graphical elements, basic points, lines, and areas.



This decomposition is exactly how we recognize unfamiliar graphics. If we do not recognize the complex object, we try recognizing its separate parts. If we recognize the parts, we combine their separate meanings to infer the identity of the whole. If we do not recognize a part, we divide it and try to recognize its parts. This recursive, top-down process continues until we make sense of the object or are stumped and either give up or seek more information. As soon as we recognize an object, however, we rarely look deeper into its parts.

As we decompose an object into simpler and simpler objects, we consider also the properties and presentation of the simpler objects to infer their meaning. At every level, the basic process is one of interpreting an object with characteristics in a presentation.

Objects

Graphical objects are the symbols we use to encode meaning in graphics. An object is something recognized by the viewer. It may be only a primitive point, line, or area, or it may be the likeness of a physical object. It may be an abstract symbol rife with emotional associations. It is whatever we process as a unit.

Because an object is whatever we see as a meaningful unit, the definition of object changes as we view a graphic. An object may be a group of lower-level objects. Objects may overlap. A low-level object may belong to two or more higher-level groups.

If an object is immediately recognized, we refer to it as an iconic image. Iconic images include faces of friends and famous people, logos for well-established products, and a host of symbols we have learned from experience.

Top-down processing

Top-down processing decomposes the graphic from the top of this hierarchy, first identifying the graphic in its context and separating backdrop from content. It then divides the whole graphic into groups and objects within groups. This decomposition may continue until the viewer finds the meaning desired.

Imagine that you are standing at the corner waiting to cross the street and your eye is captured by a bright light in your peripheral vision. You turn your head and a large red shape momentarily fills your field of view. As you focus on it you quickly recognize it as an automobile. (The bright light was the glint off the windshield.) You notice that it is a four-door sedan, and because you are considering buying such a model, you continue to stare. As you study the car, you notice more details, such as the shape of the doors, the profile of the rear-view mirror, and the fact that the mirror is cracked. Someone merely interested in crossing the street without being run over might have stopped top-down processing after classifying the car as an obstacle or threat and would not have noticed or remembered any of the lower-level details.

GRAPHICAL ELEMENTS

Ultimately all graphics can be divided into simple graphical elements. Frame, background, and graphical objects, which are made up of points, lines, and areas.

Points

A point is the simplest graphical element. A point is a mark used to represent a position in space. The mark takes up space, but the position it represents does not. The mark may take on graphical characteristics to symbolize concepts that apply at the point's position. A geometric point would be invisible. A graphical point, however, is visible. A graphical point is any small mark perceived as a location in space. We seldom see dots as isolated points. Usually their meaning relates to another object.

Distinctive point shapes

The point is the basis of all graphical objects. A point is zero dimensional. A line is just a point in one dimension; an area, in two; a solid in three; and a moving solid, in four.

In practice, a point must be about 1.5 mm (0.06 in) to display color and 2 mm (0.08 in) to show shape. The most distinctive shapes for points are the circle, plus, and dash.

Lines

Lines outline and divide figures. Typically, lines signify boundaries or directions of motion or force. Edge and curve lines represent discontinuities in texture, orientation, and value (11). The

thin, uniform line is seen as a thread leading the eye, crossing out, framing, or bordering. It represents no physical presence. If the line's thickness changes, it loses its abstract character.

Lines can also include symbols along the entire length of the line, at ends, and at regular intervals along the line.

Areas

Areas are two-dimensional forms. They represent surfaces and two-dimensional extents. Areas can carry a full range of graphical characteristics, such as shape, color, texture, and pattern.

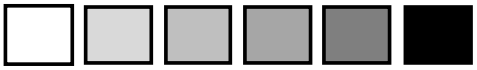
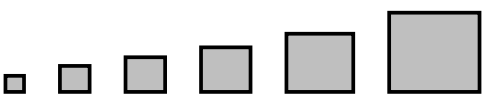
Areas

Areas are not entirely distinct from points and lines. At their smallest, areas are perceived as points. The edge of an area defines a line and any line that closes on itself or crosses itself encloses an area.

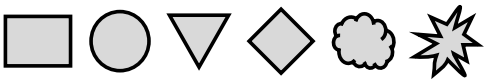
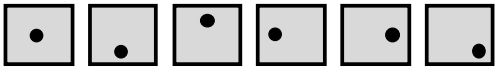
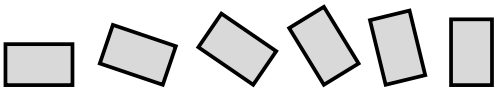
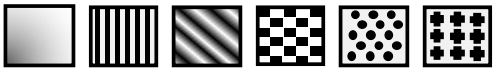
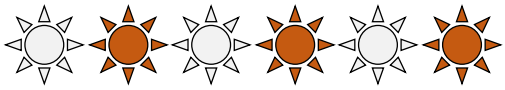
GRAPHICAL CHARACTERISTICS

Graphical characteristics refer to the visual attributes of graphical elements. Graphical characteristics serve two roles. They tell us something about individual objects that possess the characteristics and they show relationships among separate graphical objects.

Graphical properties are the characteristics of objects. These properties include tone, color, size, shape, position, orientation, pattern, texture, and dynamics. These properties may represent visual characteristics of the object, such as its physical appearance, or they may symbolize some inner characteristic, such as its ownership or importance. For instance, a square shape filled with alternating black and white squares could be a chessboard or a flag to end an automobile race.

Property	Example	Possible meanings
Tone		High contrast objects seem more important. In western symbology, black associated with death and evil.
Color		Red = danger, yellow = caution, green = safe.
Size		Bigger objects are more noticeable and seem more

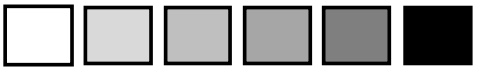
important. They may represent a higher quantity.

Shape		Rounded edges suggest living organisms. Irregular shapes are more exciting.
Position		Things higher in the frame feel lighter, more valuable, and more spiritual.
Orientation		A leaning shape seems unstable.
Pattern		Regular geometric patterns suggest order and predictability.
Texture		A fine texture suggests precision and accuracy.
Dynamics		Importance.

Tone

Value refers to the contrast of an object with its background. For printed documents, value corresponds to the lightness of the ink. Value contrast is essential for us to clearly see an object. At low value contrast, we can see fewer sizes, colors, shapes, orientations, and textures.

Tonal variation



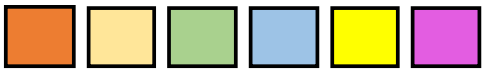
Dark-adapted eyes can detect a 10 percent lightness difference. In a bright environment eyes require a 70 percent difference. When two objects of unequal lightness are shown, the lighter will appear white and the darker, gray or black. As the lightness ratio increases, the lighter area becomes luminous like a glowing full moon.

The general lightness of the graphic affects its overall tone. A light tone suggests a friendly, playful mood. A dark tone suggests a somber, serious, or ominous mood. White is aggressive, while black is passive and recessive.

Color

Color is one of the most powerful graphical characteristics. It is so important—and difficult to use well—that Chapter 13 is devoted to using color to communicate. What we speak of as color is really three separate graphical characteristics: hue, lightness, and saturation.

Color

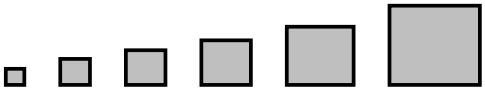


- **Hue.** When most people speak of the color of an object, they are referring to its hue. Hues are red, yellow, green, blue, and so forth.
- **Lightness.** Lightness refers to the degree of illumination of the color. Zero lightness would be black. Lightness corresponds to the characteristic we called value.
- **Saturation.** Saturation is the purity of a color. For instance, red has higher saturation than pink. Saturated colors are vivid and strong; less saturated colors are paler and are considered weaker.

Size

Enlarging or reducing an image changes the way it is perceived. We attach significance to the size of an object. In general, we pay more attention to larger objects and attribute more power and importance to then.

Size variation

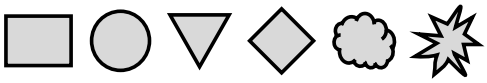


Consider these phrases indicating the importance conferred by size: *bigger is better, the big picture, large-minded, big deal, big business, Mr. Big, Big Daddy, Big Mama, big cheese, big wheel, big-league, big top, big shot, big man on campus, the Big Ten, small potatoes, small fry, small change, small-minded, smalltime,* and *small talk.*

Shape

Shape provides the outline of any object we perceive.

Shapes



Shapes can be classified along two scales:

Straight-edged versus rounded

Shapes may be bounded by straight or curved edges. Straight edges are easier to draw and easier for the eye to follow.

Hard edges represent man-made creations; soft edges, living organisms.

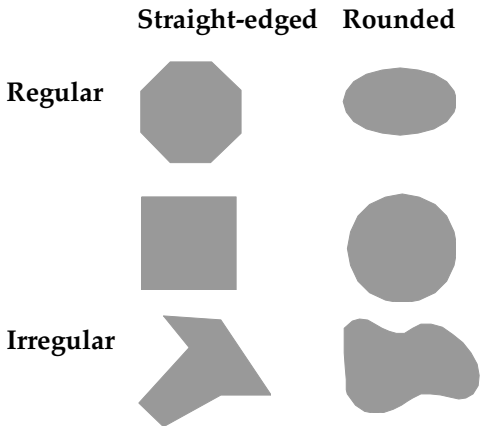
A sharp edge maintains contrast; a soft edge weakens it.

Regular versus irregular

Areas also vary in the simplicity and predictability of their edges. Regular shapes are quickly perceived and easily remembered—as well as easily reproduced. However, they are less exciting and eye-catching than irregular shapes.

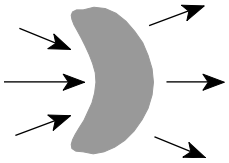
Simple, regular geometric shapes have more weight than more complex, irregular shapes.

For abstract concepts and categories, use simple regular shapes. More complex shapes will carry more associations.



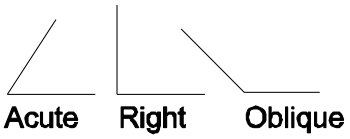
Shapes can also be classified as concave or convex. Concave shapes draw the eye inward, while convex shapes push outward.

Visual flow into convex and out of concave shape



Our perception of angles is not precise. Angles are seen as acute (less than 90 degrees), right (90 degrees), or obtuse (between 90 and 180 degrees). Angles of 180 degrees are seen as straight lines. Reflex angles (over 180 degrees) are seen as smaller internal angles.

Basic categories of angle



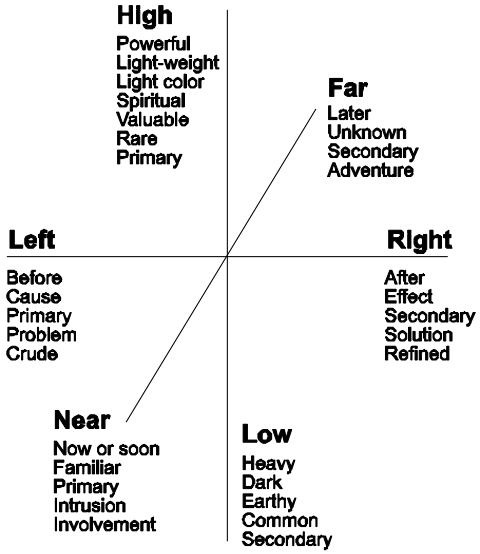
Consider the meaning conveyed by the shape of balloons in cartoons: Puffy thought balloons, smooth-edged speech balloons, and jagged-edged balloons for speech from a radio or telephone.

Position

We judge the position of a graphical object relative to ourselves, to the frame of the graphic, and to other objects in the graphic. Position is a characteristic of a visual object. We treat its position within the frame of the graphic here in characteristics. It can also be thought of as a way of presenting objects. Aspects of the position of multiple objects relative to one another is treated as a form of presentation.

Vertical position strongly affects when the element is noticed, as most graphics are scanned top to bottom. It may also suggest the importance of the object or its place in sequence. A higher vertical position strongly suggests priority in importance and in sequence. In realistic scenes, higher objects are seen as farther away. In composing scenes, keep in mind that the optical center of a graphic is actually about five percent above the true center. This is why we typically leave a larger border at the bottom of a graphic.

Position and its associated meanings



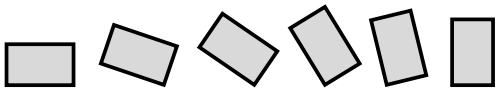
Horizontal position may also affect when an object is noticed. In cultures that read left to right, more important items are placed to the left of lesser objects, as in an indented outline. However, horizontal position is less powerful than vertical position. Left and right are nearly equal. For primitive man, food or attack was equally likely from left as from right. Modern man has trouble distinguishing b from d.

Objects can be positioned at different apparent distances from the viewer. Techniques for conveying depth in a flat image include monocular cues, that is, indicators of depth that do not depend on binocular vision. They include overlap, linear perspective, aerial perspective, shadows, and shading.

Orientation

The angle or orientation of a figure relative to the viewer and other objects gives it an identifiable character. Usually we are vertical when awake, horizontal when sleeping, and diagonal when falling. Therefore, a horizontal orientation of a figure suggests stability and repose; a vertical orientation offers energetic potential; and a diagonal orientation conveys instability and excitement.

Variations of orientation

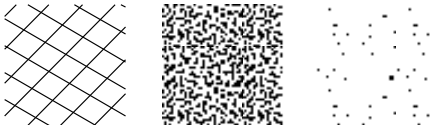


Orientation also strongly affects how well objects are recognized. We cannot recognize upside-down faces quickly or accurately. Recognition for text, shapes, and faces deteriorates with increasing rotation.

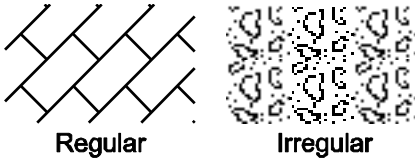
Pattern

Pattern refers to a repeated visual characteristic along a line or over an area. Patterns can be regular or irregular.

Variations of pattern



Regular and irregular patterns



Pattern provides valuable clues about the world. Patterns can represent tactile sensation. Patterned areas are usually solid, but unpatterned ones are sky or water. Graininess suggests coarseness, crudeness, vulgarity, and violence. All of these clues help us decide where to step, how to grasp, and when to duck. In technical graphics, they represent characteristics of surfaces, thereby making objects more recognizable.

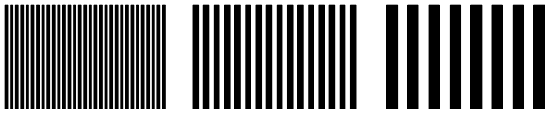
Texture

When we refer to the texture of a piece of fabric, we are concerned with how it feels to the touch. Is it smooth or coarse? Are threads fine and closely spaced or large and loosely woven? When we

refer to the visual texture of an area, we are likewise concerned with the fineness or coarseness of the constituents of an object.

Texture is usually described in terms of the number of lines or marks for a given area. It results from varying the scale of a pattern of marks, but not the pattern of marks itself. Varying texture does not change the overall balance of light and dark (the value) of an area.

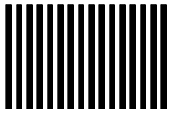
Variations in texture



At the limit of fineness, we can identify no individual marks in a texture. These limits of fine texture are determined by the display medium. Photography, microfilm, typesetting, laser printing, and computer displays all impose different limits. As scale changes, repeated objects become pattern, texture, and eventually value.

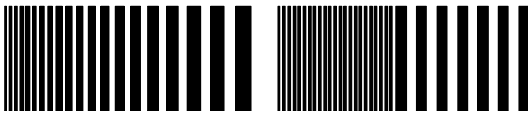
Medium values of texture produce a shimmering or vibratory effect of reversing figure and ground. This powerful effect is highly selective but is most annoying when misused or when it occurs by accident. The effect seems most prominent with a 1 mm texture of 50 percent value.

Shimmering texture



Gradual changes in texture indicate changes in the orientation of the surface relative to the viewer or the source of light. The pattern of changes tells whether a surface is flat or curved. Sudden changes of texture indicate edges, folds, or creases.

Changes of texture

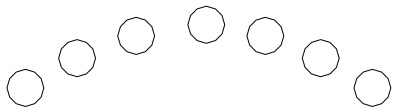


Dynamics

This book is primarily concerned with static images—ones in which graphical objects do not change over time. But for computer and television screens, dynamics dominate the display and without them the display would be dull and mute. Some of the dynamic graphical characteristics include:

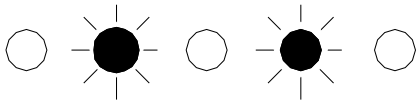
- **Motion**. The object may move about the display. It may move smoothly along a curve or zigzag erratically.

Motion



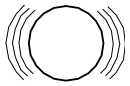
- **Blinking**. The object may alternate graphical characteristics; for instance, it may flash bright and dim or pulse first red and then green.

Blinking



- **Vibration**. The object may shake in place, its size or shape alternating rapidly.

Vibration



Dynamics are compelling. They are the only graphical characteristics completely effective in peripheral vision. A moving or blinking object demands attention. Dynamics should be used sparingly and only for the true subject of the graphic.

Combinations

Applying graphical characteristics to graphical objects and elements is tricky. Some objects work better than others with certain characteristics. The following table offers advice.

	Element		
	Point	**Line**	**Area**
Dynamics	The eye can easily follow a moving point—provided the point is large enough and the motion is not too fast or too erratic. Blinking and vibration are quite effective in drawing attention to a small point.	The eye can follow the motion of only a small line segment. Keep moving lines short and simple and make their motions straight and direct.	Moving areas are difficult to follow, unless the area is small (almost a point) and the motion is simple.
Value	Use up to three levels of value.	Use up to four levels of value.	Use up to five levels of value.
Color	Because points are small, limit them to no more than four distinctive colors.	Because lines are thin, use only six contrasting colors.	Positive areas can use six to eight distinct colors.

	Element		
	Point	**Line**	**Area**
Size	People can distinguish only about four sizes of points. Drawn too large, points are seen as shapes, not points.	Viewers can distinguish about four widths of lines. Thin lines, especially in a grid, connote scientific and technical precision. Broad, clear lines convey a sense of confidence and strength. Delicate, flimsy lines can appear weak and indefinite, as if the ideas they present were tentative. Use heavier lines for the shaded side of an object. Use different line weights to distinguish overlapping objects.	Areas can vary freely in both length and width. In general, viewers can distinguish five sizes.
Texture	Points are too small to display texture well. Limit texture to two or three values.	Lines display texture as a dashed or dotted line, produced by regular breaks in the line. Use up to four line-textures.	Areas can use texture freely. Use four or five textures.
Pattern	Points can display only two or three distinctive patterns.	Use dashed or dotted lines for imaginary or hidden lines. Limit line patterns to solid and one or two dash patterns.	Use up to four patterns.
Shape	Points can take on only a few simple shapes. Complex shapes are easily confused. For overall selection, use circles, dashes, and crosses as they are the most distinguishable shapes. Make the dash four times as long as wide. The cross may produce a shimmering effect. To be legible as a shape, a mark must be at least 2 mm in size.	Lines can be straight, jagged, or curved. The slight irregularities of a freehand line give it a natural, human quality in contrast with the mechanical precision of the smooth, uniform line of the draftsman. Use straight lines to suggest a simple, monotonic change. Use jagged lines to indicate that only part of an object is shown and to suggest abrupt, dynamic change. Use smooth lines to suggest continuity and to make following the line easier.	A triangle implies upward movement (when point is upward), downward movement or slowing (when point is downward), stability, the number 3, a trinity. Square shapes imply stability, solidity, firmness, balance, order, the number 4. Rectangular shapes imply security, rationality, grounding—especially if the base is broader than the height. Circles imply unity, oneness, permanence, continuity, eternity, marriage.
Position	Points can be positioned vertically, horizontally, and relative to other objects.	Lines can be positioned vertically, horizontally, and relative to other objects.	Areas can be positioned vertically, horizontally, and relative to other objects.

	Element		
	Point	**Line**	**Area**
Orientation	To convey orientation, a point must have a 4:1 height:width ratio. For selective tasks, restrict orientation of points to four values: horizontal, vertical, 30 degrees, and 60 degrees.	Lines can be horizontal, vertical, or diagonal. Most lines we encounter in daily life are horizontal or vertical (11). For selective tasks, restrict orientation of lines to directions parallel and perpendicular to the line. The only oblique line we can gauge with any accuracy is 45 degrees.	Shapes may be rotated to any orientation. Rotation may make the shape less recognizable or even transform it into another shape.

PRESENTATIONS ARRANGE OBJECTS

The presentation of a graphic is the arrangement of objects. Objects can be arranged in space and in time. In computer-based graphics the presentation of objects can depend on interaction between the user and the computer.

Spatial arrangement

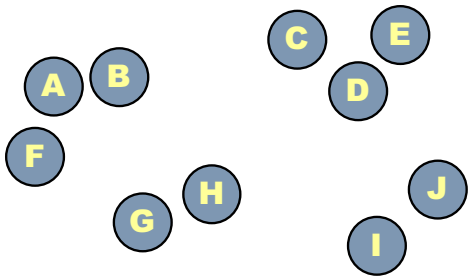
A graphic arranges objects over an area. This selection and positioning is called layout in graphic design, composition in photography and painting, and *mise-en-scene* in film. Where an object occurs tells us something about the object and its relationship to other objects.

The position of the object relative to the frame (horizontally and vertically) as well as its position in depth (near or far) are treated as a graphical characteristic. Just remember that it is also an element of spatial arrangement.

In addition to position in the frame, spatial arrangement involves design choices for proximity, symmetry, enclosure, and connection.

Proximity

Proximity is the object's position relative to other objects. Objects close together are seen as related. The eye naturally jumps from object to nearby object. For example, what items seem associated with A?



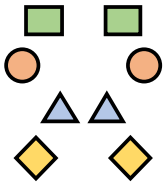
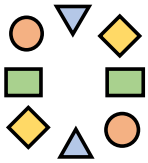
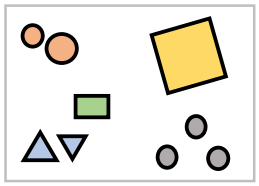
The clustering of small objects around a large one portrays the large object as dominating and protecting the smaller ones.

In positioning objects in space, it is useful to think of them as governed by forces of gravity and magnetism. The eye is drawn to the center of an object or cluster of objects (the center of gravity). Objects close together seem linked to one another (magnetic attraction).

Symmetry

Objects arranged in symmetrical patterns are seen as related and sharing characteristics. Symmetry can make an image seem simpler, better organized, and more attractive.

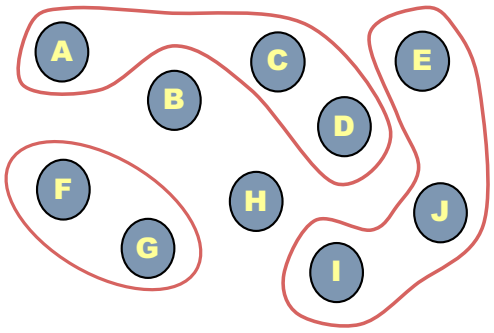
Three types of symmetry are common in design:

Type	Example	Description
Lateral		Objects are mirrored in equivalent positions across an imaginary straight line. That line can be vertical, horizontal, or diagonal.
Radial		Objects repeat on opposite sides of a central point.
Dynamic		The prominence of a different object balances over an area or about a point.

Enclosure

In enclosure, an object or just a line surrounds a number of objects thus identifying them as related. The surrounding form can be a circle, oval, rectangle, or some other shape. It can also be a graphical object in its own right.

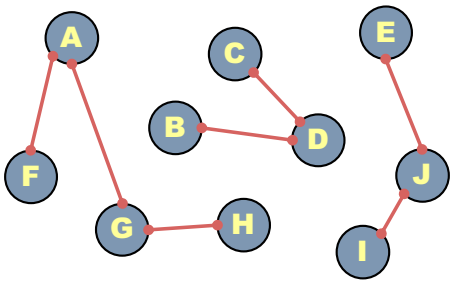
Here, which items are more closely related to A?



Enclosure works on the principle that the eye prefers to follow rather than cross a line or edge. Thus, it becomes easier for the eye to visit items within the enclosure than those outside.

Connections

Connections visually link separate objects. Objects may be connected by lines or other shapes. Diagrams commonly connect geometric shapes with arrows indicating that one shape affects another or that one precedes another.



Connected objects are always seen as more closely associated than unconnected objects.

Temporal arrangement

Moving images arrange objects in sequences as well as in space. The order and tempo with which objects appear and disappear can affect how we interpret the objects and how we react to them. Here are just a few of the ways of arranging objects in sequence.

Montage

Quickly jump from object to object. Rock-music videos and early films both rely heavily on montage for excitement.

Evolution

Gradually, one object changes to become an entirely different object. The special effect of morphing epitomizes this technique.

Alternation

Switch back and forth between two objects. Much of the excitement of a car-chase scene comes from rapid cuts between the chaser and the chased.

Cycle

Show the same series of objects over and over again. This is the basis of the TV series.

Climax

Build from least to most. Thriller movies follow this order to increase suspense and excitement at the end.

Anti-climax

Go from most to least. This is the classic inverted pyramid structure of journalism, where the most important news is presented first in case the reader or viewer stops before the end.

Logical arrangement

With computer-controlled displays, the appearance of an object can depend on conditions sensed by the computer and on interaction between the computer and its user.

Conditional display

Conditional display has the computer determine what image appears, where, and when. For instance, the designer of graphics to represent different product options may write a simple program to present the graphic that most resembles the model on the user's computer.

```
if (modelVersion == "47B") {
     mainIcon = "Model47Rev2"
} else {
     mainIcon = "Model46"
}
```

Interactivity

The designer may leave the choice of what graphic to display to the user. The user may be offered alternatives or a choice of graphics.

> The DrewidX is available in two models: the simpler Model 46 and the more full-featured Model 47B.
>
> Show Model 46
>
> Show Model 47B

PRINCIPLE OF DATA-MAPPING

All technical graphics are built on a principle so simple that you probably know it already but have never paused to examine it. When you do, you realize that it can explain the tremendous

variety of technical graphics in use and can suggest creative new graphical forms. The principle of data-mapping is:

> **Use graphical objects to represent concepts and graphical characteristics to represent corresponding dimensions or traits of these concepts.**

For most graphics, we are not aware of the mapping because it is determined either by the conventions of a standard graphical form, such as a perspective drawing or line graph, or because it is supplied by the instincts of a creative designer.

How to encode visual meanings

Assigning symbols for concepts involves an iterative process.

1. **Pick a graphical symbol** for the concept. For example, to compare the speed of various processors, you might select a bar to represent each processor.

Graphical symbol

2. Pick a graphical characteristic. Decide which graphical characteristics will represent characteristics of the concept. Here the length of the bar will represent the speed.

Graphical characteristic

3. **Choose a scaling function**. Define an algorithm, procedure, or heuristic to assign graphical values for data values. The scaling function can be linear, logarithmic, or geometric.

Scaling function

length = scale factor x speed

4. **Choose a scaling parameter**. Calibrate the assignment of graphical characteristics to the particular display.

Scaling parameter

1 mm = 1 MHz

Pick a graphical symbol for the concept

Showing concepts as visually separate objects keeps them from getting jumbled or blurred in memory. In notational symbol systems, each symbolic object in the graphic directly represents one object of the subject. Maps, for instance, use clearly distinguishable symbols. In non-

notational photographs, however, smooth gradations of tone and texture make distinguishing one object from another difficult.

In mapping concepts, don't forget practical considerations, such as the size of the graphic, the size of the mark necessary for perceptually separable symbols, and the number of categories that the reader can readily recognize.

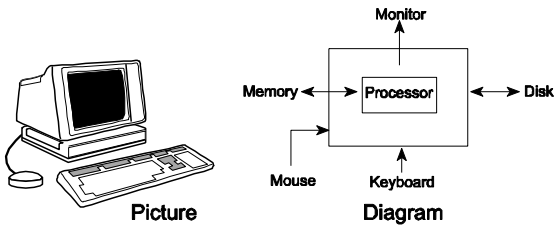
The strategy for selecting graphical objects will blend techniques of mimicry, analogy, projection, aggregation, and filtering.

Mimicry

The most direct form of mapping is to ensure a physical similarity between real-world and graphical objects. With mimicry, the graphical object looks like its counterpart.

We must distinguish between illustrations that show *what is* and those that show *what something looks like*. This is the philosophical distinction between knowing and seeing. Pictures show the appearance from one viewpoint at one moment. Symbolic illustrations, such as diagrams, show the essential facts that apply universally.

Mimicry versus symbolism



Use mimicry to teach and to focus attention. For initial teaching of concepts show critical features realistically. Also use realistic details to focus attention on individual objects rather than overall patterns.

Analogy

Analogy is the direct representation of the characteristics of the object but not of its visual appearance. It is appropriate when it is more important what something is or does than what it looks like. Analogy is thus useful in computer documentation where we must make the invisible inner workings of hardware and software comprehensible. Analogy is also useful when a procedure can be performed in several ways, but we are only interested in the results. Use analogy to create simplified visual symbols, diagrams, and drawings:

- To explain how something works
- After initial learning when only recognition is needed
- If the viewer must focus on the big picture and process the graphic holistically
- When using visual analogy, make clear the limitations of the analogy before releasing the readers.

Projection

By the technique of projection, we create a deliberately ambiguous visual image onto which viewers can project their own interpretations, much like a Rorschach ink blot. Projection is a risky technique because some viewers may project an image quite different from the one you intended. Still, projection is useful provided:

- Graphics are not specific
- Viewers can supply missing details
- Missing details are not essential to the point you are making

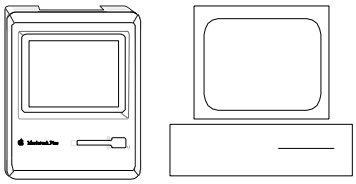
For example, if your program runs on many different models of computer, you might present an ambiguous shape with only enough details to clearly suggest a computer but not enough details to represent a particular brand or model.

Aggregation

Aggregation simplifies a graphic by letting one object represent multiple concepts. Forms of aggregation include:

- **Generalization**. To generalize a graphic, omit identifying details. To show a particular object or event, include and emphasize identifying details.

Generalization



- **Categorization**. Divide objects into categories and show all members of the same category with identical symbols.
- **Grading**. Let each graphical object represent a range of numerical values; for instance, bands of color on television weather maps represent ranges of temperature.

Filtering

Filtering selects which objects and details are included and which are not. In general:

Seek out and include	Exclude
Essential concepts, facts	Nice-to-know information
Crucial details, such as edges and creases in drawings	Irrelevant and distracting details
Trends and overall patterns	Anomalies and exceptions (unless they are the subject)

Pick a graphical characteristic

The graphical characteristics you assign to each object depend on the meaning you want to convey. For example, here are how some common graphics use graphical characteristics:

Type of graphic	Dimension or characteristic in the data or subject of the graphic	Corresponding graphical characteristic
Column chart	Category of data	Horizontal position of the bar
	Data value	Height of the bar
List	Sequential order of an item	Vertical position in the list
	Nature of the item	Shape of bullet or other mark
Table	First indexing category	Horizontal position of column
	Second indexing category	Vertical position of row
	Subcategories	Indentation of row head
Diagram	Type of concept	Shape of symbol
	Type of relationship	Style of line connecting symbols
Line drawing	Outer edges of the subject	Heavy lines
	Inner edges of the subject	Moderate lines
	Creases in the subject	Light lines
	Position of the subject	Position in the drawing
Photograph	Position in field of view	Position in graphic
	Lightness of subject	Lightness in photograph
	Color of subject	Color or lightness in photograph
Map	North-south position	Vertical position
	East-west position	Horizontal position
	Type of feature	Shape, color, size

The characteristic chosen must be able to fully represent the corresponding real-world characteristic or dimension. For instance, a continuous variable, such as time or location, cannot be represented by a characteristic with spaces or gaps. Likewise, a ranked series needs a characteristic with as many discriminable steps as the series.

Some general recommendations follow:

	What you need to express			
Characteristic	**Similarities**	**Categories**	**Order**	**Quantity**
Position	■	■	■	■
Size	□	□	■	■
Value	□	□	■	
Texture	■	■	■	
Pattern	■	■		
Color	■	■		
Orientation	■	■		
Dynamics	■	■		
Shape	■			

Note: ■ = recommended □ = possible but not recommended

Remember that you are not limited to one graphical characteristic per concept. Double-cue or redundant coding can help viewers work with complex graphics by giving viewers a second way to spot or recognize symbols. Redundant coding works well even on extremely complex graphics.

Choose scaling functions

The next step is to define an algorithm, procedure, or heuristic to assign graphical values for data values. This scaling function is most easily identified in statistical graphics where, for instance, the length of a bar might be proportional to the numerical value it represents.

In many graphics, the scaling function is provided by the production process. The optics of the camera ensure that what is vertical in the scene is vertical in the photograph. In mapping, conventions ensure that a northward direction is mapped to a vertical direction on the paper or screen. In drawing, rules of perspective rendering ensure correspondence between subject and image.

For the sake of the designer and the viewer of the graphic, the scaling function should be simple and direct. A logarithmic or geometric scaling of data values often confuses or misleads unsophisticated chart readers.

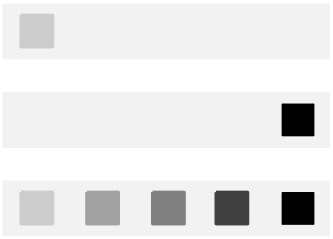
Choose scaling parameters

Calibrate the assignment of graphical characteristics to the particular graphic. The scaling factor is chosen to fit the range of information to the space available and to ensure that all symbols are legible. The scaling parameter may just be a scale factor, such as 1 cm on the map representing one kilometer on the earth, or as sophisticated as a compression or expansion of the range of gray tones in a photograph.

In scaling characteristics:

- Make the lowest value sufficient to stand out from the background and visual noise.
- Limit the highest value to prevent overpowering other parts of the graphic or losing identity of individual objects.
- Express the necessary steps between highest and lowest value.

Scaling graphical characteristics



Strive for direct mappings

Graphical objects express meaning by association or mapping. Direct associations which work by visual analogy rely on human pattern matching and require little learning. Arbitrary associations rely on memory and require learning.

We can arrange all graphic associations on a scale from the most direct to the most arbitrary. Using this progression, here are some associations found in graphics:

- Lightness in photographs
- Positions of lines in line drawings
- Length of bars in bar charts
- Shapes and textures in cartoons
- Visual symbols based on simplified physical objects, such as road signs
- Visual symbols based on arbitrary shapes, as in schematic diagrams
- Text and mathematical symbols

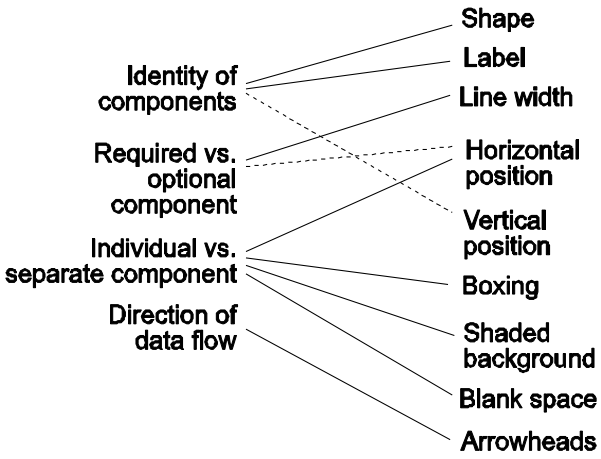
Analyze graphical mappings

One of the best ways to study and improve graphical mappings is to study the mappings of existing graphics. To analyze the mapping of an existing graphic:

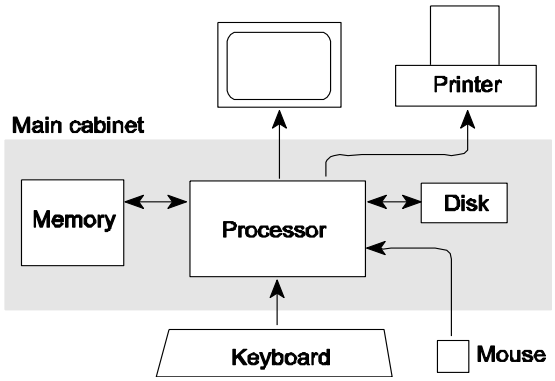
1. In one column list the meaning the graphic should express.
2. In another column, list the graphical characteristics used in the graphic.
3. Draw lines from each meaning to the graphical characteristics used to represent it.
4. Draw lines for each characteristic to the meanings it represents.

Now review the results. Meanings with no corresponding characteristics will not be conveyed. Meanings with multiple characteristics are redundantly encoded and are more likely to be

understood. Characteristics representing multiple meanings are ambiguous and can lead to confusion. Characteristics with no corresponding meaning are either decoration or noise.



Notice that identity is redundantly represented by shape and label. This meaning is reinforced by vertically positioning objects as they might appear in the viewer's field of view: The monitor is above the cabinet and the keyboard is below. Horizontal position is used both to separate components and to suggest that those to the right are optional. These mappings are not consistent, because the disk is separate but not optional. Confusion is avoided by ensuring that horizontal position is used only as a redundant, secondary mapping.



Follow standard mappings

Each graphical idiom has its own rules. In the Venn diagram, overlap represents relationship. In the organization chart, relationship is shown by position on the page and by lines of authority. In a flowchart, arrows symbolize relationships in time. If there is an established, expected form for what you have to say, use it. Don't be afraid to use visual clichés. If no standard form exists for what you have to say, create one using the principle of mapping.

MAKING VISUAL STATEMENTS: A BASIC PHRASEBOOK

Of the millions of combinations of graphical elements and characteristics, not all are equally effective for a given purpose. This section provides guidelines for creating effective graphical structures. It reviews strategies for helping viewers find and remember the information they seek.

This exists: Make an object stand out from the background

For us to even perceive an object, we must see it as distinct from the background. The graphic must have good figure-ground contrast. Background contrast is the most important factor in legibility and recognizability of images and their colors. Photographs with distracting clutter and trees growing out of people's heads result from the photographer's tendency to ignore the background and attend to the subject.

Characteristics of background and object

Background	Object
Large	Small
Unbounded	Bounded
Unbordered	Bordered
Continuous	Discrete
Dark, dim	Light, bright
Farther	Nearer
Peripheral	Central
Cool colors	Warm colors
Unsaturated colors	Saturated colors
Concave	Convex
Static	Dynamic
Untextured or unfeatured	Textured or featured
Upper area	Lower area
Diagonal	Vertical or horizontal
Asymmetrical	Symmetrical
Complex shape	Simple shape
Abstract	Realistic

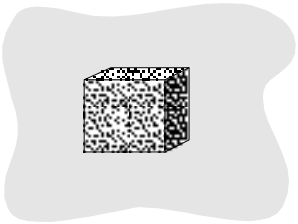
If text or pictures are superimposed on a background graphic, the original may become unrecognizable and just distract the reader from the real subject. For example, several tutorial screens for Microsoft Excel 2.2 on the Macintosh use the Excel emblem as a backdrop for text and

graphics. The graphics cover so much of the emblem that all the viewer sees of it are isolated, amputated shapes—distracting and meaningless.

This is primary: Single out one object

We cannot see or even think of something unless we identify it as separate from all other things. To show something, we must contrast it with everything else or make it stand out from the background and from other objects. To do so, we must give it different graphical characteristics from objects nearby.

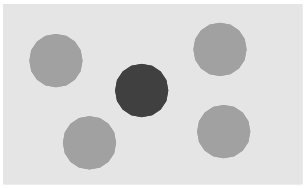
Object on background



Design graphics to draw attention to the essential information, especially if it is unfamiliar to the reader or differs from what the reader expects. Techniques to call attention to the subject include:

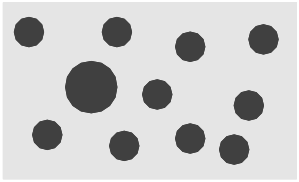
- **Display the object in higher contrast** with its background. If the background is light, make it the darkest object in the scene. If the background is dark, make it the lightest.

Add contrast



- **Paint the object in a bright, saturated, warm color**. Use brighter, warmer, and higher-contrast colors for emphasis. Warm colors (red and yellow) tend to emphasize, while cool colors (green and blue) tend to deemphasize.
- **Make the object larger**. Larger objects appear more important. For objects next to one another, a 5 percent difference is noticeable. If objects are in separate parts of the display, a 30 percent difference may be required.

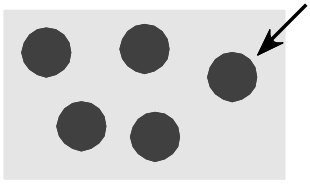
Enlarge the object



- **Point to the object**. Use elements in the graphic to direct the viewer's eyes to one particular graphical object:

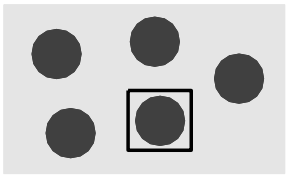
- Include arrows pointing to the object.
- Compose the scene so that lines naturally converge on the object.
- If the graphic includes people, have them looking or pointing at the object.

Point to the object



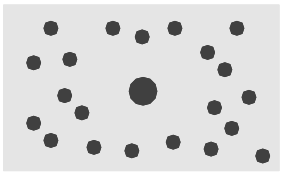
- **Frame the object**. Use objects in the scene to form a halo, border, or box around the subject.

Frame the object



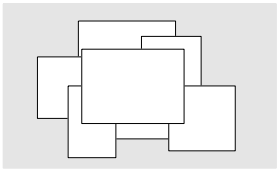
- **Isolate the object**. Surround the object with blank space. This halo of blank space is especially effective in an otherwise crowded graphic.

Isolate the object



- **Show the object in front of other objects**. Immediacy gives weight and importance to graphical objects. Things that are nearby are more useful or more threatening. To emphasize one object, let it overlap other objects in the graphic.

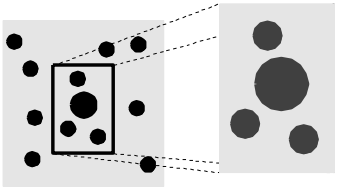
Present object in front



- **Show the object in motion**. People pay longer and deeper attention to objects shown in action than to ones in a static pose. Blinking or moving objects always take priority in our attention. However, only one object should be shown moving or blinking. Urgency can be suggested by the rate of movement or blinking, but don't expect viewers to be able to distinguish more than 2 or 3 different rates.

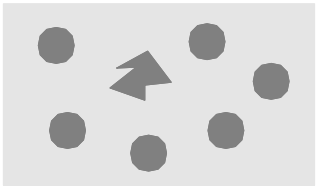
- **Show fewer objects or just the important part of the subject**. To focus attention on part of the screen, show a partial view.

Show just the subject



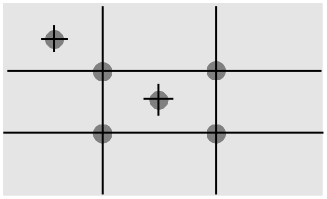
- **Increase detail in the object.** Detail is lively texture that draws the eye and rewards it with new information. Our eyes gravitate to detailed sections of the graphic and spend more time there.
- **Focus on the subject**. Ensure that the subject is in crisp focus or drawn with sharp lines. Let other objects fall out of focus. When photographing moving objects, let the camera move to follow a moving object and use a moderate shutter speed. Doing so will blur the background while leaving the moving subject in clear focus.
- **Give graphics, especially photographs, a clear center of interest**, a single object that draws the viewer's eye to one spot.
- **Give the object a distinctive shape**. Jagged, irregular shapes are more eye-catching than smooth, regular ones.

Use a distinctive shape



- **Position the subject at a hot spot**. Certain locations in a graphic are more likely to draw attention than others. By placing the subject at one of these hot spots, we ensure the viewer notices it. Hot spots include the center, the upper-left corner (in left-to-right reading cultures), and the points one-third and two-thirds of the way from top to bottom and left to right.

Put in hot spot



All emphasis depends on contrast. In a graphic filled with large, red, diagonal objects, a single small, blue, horizontal object will dominate. This principle is the visual equivalent of whispering to be heard in a noisy room. The goal is to make the emphasized object visibly unique.

In pure graphics, there is no baseline of neutral emphasis—all graphical characteristics vie against one another. On the page, however, body text is the baseline or ground against which all other elements are measured. You emphasize objects by making them more prominent than body text and subdue them by making them less prominent.

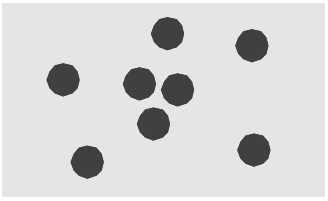
Limit the amount you emphasize. Any emphasis device loses its effectiveness if overused. Highlight no more than 10 percent of the items in a graphic.

These are a group: Establish a family of objects

In many graphics, the essential message is the relationship among separate objects in the scene. How can we show that separate objects are similar?

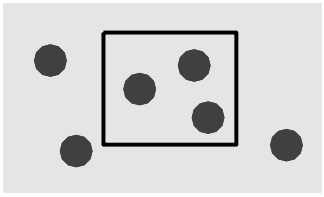
- **Cluster the objects together**. Proximity links the objects to each other and blank space distinguishes them from unrelated objects.

Cluster objects



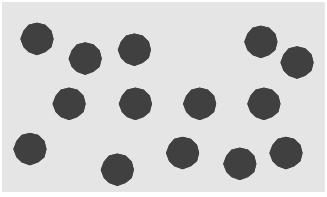
- **Draw a box or border** around the group of related objects.

Box objects



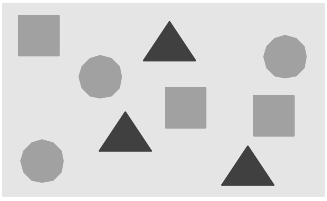
- **Arrange the objects in a simple geometrical pattern**, such as a circle, a row, or a column.

Align objects



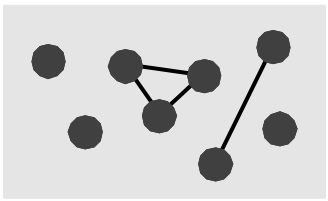
- **Use similar graphical characteristics**. Display related objects using similar visual characteristics, such as color, texture, shape, or orientation. Color is especially effective in showing relationships between distant objects.

Use similar graphical characteristics



- **Connect the objects**. The eye naturally follows thin lines and will shuttle between two objects connected with a line. A simple line expresses a reciprocal relationship, while an arrow indicates a one-way relationship.

Connect objects with lines



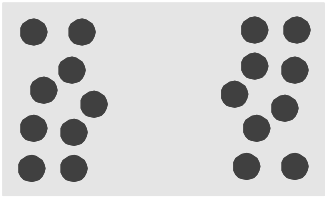
- **Show objects in sequence**. To imply a causal connection between two events, show them one after the other. Such temporal proximity strongly implies that the first caused the latter.

These are different: Show contrast

Often, we must tell the viewer that two objects are similar—but not quite the same. Without contradicting the similarity of the objects, we must nevertheless help the viewer see the essential differences.

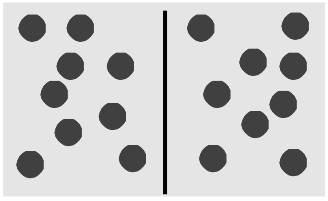
- **Separate by blank space**. Just as proximity associates two things, distance separates. In page design, typographers often use white space to separate different pieces of information.

Separate with space



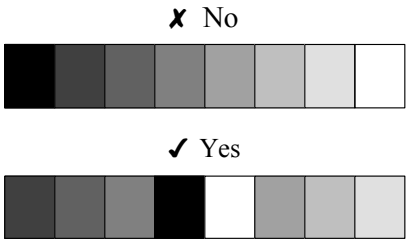
- **Separate with rules and lines**. Rules and lines provide fences for the wandering eye to keep it from inadvertently straying into unrelated information.

Separate with lines



- **Juxtapose opposites**. One way to highlight differences is to place them side by side so they are obvious in a single glance. For instance, the light-dark extremes of this figure are more obvious when the shades are rearranged so the most different ones are juxtaposed, without the insulation of intervening objects or space.

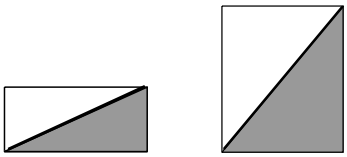
Increase apparent gradient



- I**ncrease the apparent gradient**. Select a scaling function that emphasizes differences like turning up the contrast on your TV.
- **Expand scale**. Another way to increase the apparent gradient is to expand the scale against which the change is measured or displayed.

Expand scale

change this **to this:**



What order: Show rankings

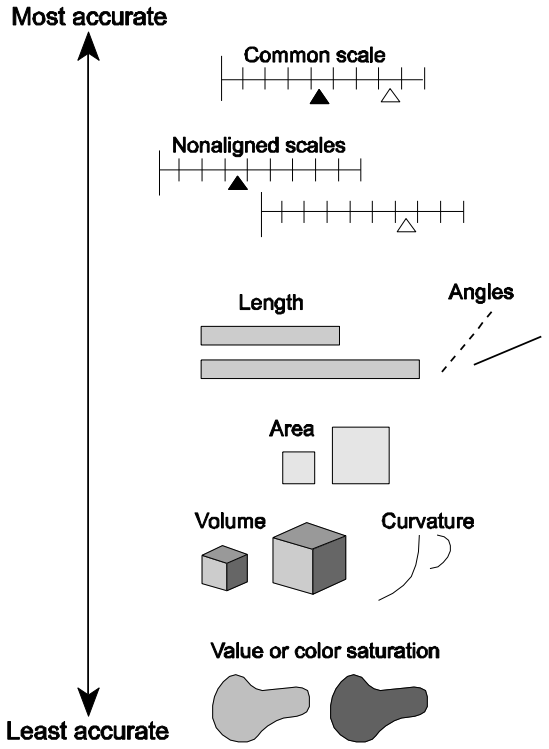
To show the order of ranked or graded items, represent them with graphical characteristics with a corresponding range of distinctive values.

Characteristic	Number of steps recognizable	Step size
Position	Many, almost infinite	Limited by visual acuity or display resolution
Value	20	30 percent
Size	20	30 percent
Warm–cool color scale	4	Red, yellow, green, blue
Light–dark color scale	5	Two ranges possible: yellow to red and blue to yellow

How much: Show quantity

To display quantitative values, we represent them with continuous graphical characteristics in a wide range (ratio of highest to lowest) of values.

Scale of perceptual accuracy



From most to least accurate, perceptual judgments are:

1. Position along a common scale
2. Positions on identical but nonaligned scales
3. Length, direction, angle
4. Area
5. Volume, curvature
6. Value, color saturation

Although a gradual transition between values of characteristics may more accurately represent the data, human perception cannot judge absolute values accurately enough to make use of such subtleties. Divide the range into a few segments and represent each distinctly. Weather maps, for instance, show temperature by bands of distinct colors (one for each 10 degrees F), not continuous shading. Contour maps show elevation at specifically regular intervals, not continuously.

Remember this: Ensure ideas are remembered

Some things are remembered longer and more accurately than others. If the purpose of your graphic is to present information that the viewer must recall later, try these psychologically proven techniques for making it memorable. We tend to remember objects that possess the following characteristics:

- Repeated, especially if repeated in a different form
- Emphasized or exaggerated
- Unusual or even bizarre
- Single, vivid images
- Active or interactive
- New and interesting
- Concrete, rather than abstract
- Labeled and grouped by the characteristic to be recalled

Keep this list in mind next time you watch a television commercial. Advertisers want their products to be remembered and they use these techniques liberally. Those who explain computer systems can use them too—perhaps not so blatantly.