Our senses don’t deceive us; our judgment does.

— Johann Wolfgang von Goethe
The visible spectrum...

- ... is the part that we can see of the electro-magnetic spectrum.
- The visible spectrum contains millions of colors of varying wavelengths.
- Light from the sun contains all of these colors. A prism splits these colors into the familiar rainbow.
Sir Isaac Newton (1642-1726) was the first to understand the visible spectrum.

He refracted white light with a prism, resolving it into its component colors, then used another prism to reverse the process.
The eye has receptors sensitive to the primary colors red, green and blue. Stare at the dot in the middle of the red square for 30 seconds, then shift quickly and stare at the dot in the white square. What color do you see? Red stays on the retina as an after-image of its complementary color, cyan blue.
Now stare at the dot in the middle of the white star for 30 seconds, then shift to the dot in the white square. What do you see?

- After-images are due to rods and cones in the eye becoming sensitized. Rods and cones are photoreceptors on the retina.
- The rods, about 120 million, are not sensitive to color.
- The 6 to 7 million cones are color sensitive. They are concentrated in the macula, a spot in the center of the retina.
Additive color

- The receptors in the eye are sensitive to the primary colors red, green and blue.
- These are called the additive primaries, or projected-color primaries.
Additive primaries (red, green and blue) are used to reproduce color on a TV screen, in color film and on a computer screen.
Red, green and blue (RGB) are called additive primaries because as each color is added to a black screen, they blend to form lighter colors.
Where RGB overlap, complementary colors form. When we stared at the red square, we developed an after-image. When we switched to the white square, we saw that after-image as cyan, the complementary of red.
Projected color

With additive color, the three primaries of red, green and blue are projected one on top of the other to form a composite image. Where all three are present, such as the background, the result is white.
Subtractive color

- Cyan, magenta and yellow for the **subtractive primaries**. These are complementary colors to red, green and blue.
- These subtractive primaries, along with black, are used in printing in what is known as the **four-color process**. The shorthand for this is CMYK, with “K” standing for black.
With subtractive color, as we subtract color, we get closer to the white of the page.

Where no ink is present, we see white, or as close to white as the paper gets.
Because the paper is never pure white, and because the inks are never pure cyan, magenta and yellow, the colors can look dull without black to add shadow and detail.

Subtractive color sometimes is called \textit{reflected color} because it is used in printing, where the ink on the page absorbs colors of some wavelengths and reflects others.
Remember that in additive color, as we add more and more red, green and blue light, we approach white.

With subtractive color, it's the other way. As we subtract cyan, magenta, yellow and black ink, we get closer to white.
A color separation

Before a color picture can be printed, it is separated into its CMYK. Digital pictures are stored in separate channels for each primary. With this separation, the white is produced by an absence of ink in any of the four colors.
Black undercolor

- Black ink is necessary because no ink is pure in color and no paper is a pure white.
- The black ink provides contrast and saves money because less colored ink is needed to make the black and gray tones.
- The picture to the left has no black undercolor.
The colors in additive or subtractive color are not “mixed” but rather presented individually. The eye does the “mixing,” creating an illusion of color similar to that of French artist George Seurat.

Seurat portrayed the play of light by using tiny brushstrokes of contrasting colors. The style became known as pointillism.

He created huge compositions with tiny, detached strokes of pure color too small to be distinguished when looking at the entire work; it made his paintings shimmer with brilliance.
Other artists have used similar techniques, believing that the colors seen by the eye appear more pure and vibrant than those created by mixing paint.

Paul Klee used a mosaic technique (above), while Chuck Close uses small squares, each a tiny abstract painting, to produce an overall image.
The grayscale halftone

- Black and white printing uses two tones: The white of the paper and the black of the ink. To simulate gray tones, printers use the **halftone process**.

- A computer algorithm analyzes the gray tones in a photograph and substitutes tiny dots of black to simulate the gray tone.

- The black dots vary in size, approaching complete coverage (100%) or dwindling to no coverage (0%). When the dots are very small, the eye sees gray that is almost white.
The color halftone

- In a color halftone, the image is **separated** into cyan, magenta, yellow and black.
- Each of the four images in the separation is converted into a halftone.
- As with black and white, the **density** of each of the colors is measured by the percentage the dots cover.
- Each CMYK color is printed separately one atop another.
- Each color of the halftone is printed at a different angle so that the dots do not overlap.
- Where the colors come together, “rosettes” form in a characteristic circular pattern.
In this halftone sample, each of the four colors (CMYK) is printed with uniform 20-percent dots.

In both color models, when all primaries are in equal amounts, a shade of gray is produced.
Photographic color

- In a photograph, even areas that look smooth and uniform in color will have small variations in dot size.
- Variations in dot size give the photo a 3D texture by adding depth of shadow and tone.
- In a digital photo, these variations can be seen by enlarging the photo until the pixels are visible.
Flat color

- For illustrations, color is applied in uniform percentages over large areas, producing **flat color**.
- The CMYK dots are even in size and are evenly spaced.
- In a digital images, pixels are uniform in color.
Spot color

- Inks can be mixed like paint using a color matching system such as Pantone. The mixed ink can be used in flat-color illustrations.
- Using one or two **spot colors** saves money over four-color process.
- Spot colors are specified on the printing order.
- The printer looks up Pantone formula and mixes the ink.
- “C” stands for coated paper.
A color gamut is a subset of colors that can be accurately represented within a given color space or by an output device.

The additive gamut (RGB) and the subtractive gamut (CMYK) are radically different.

Also, different monitors and printers vary in the gamut they can reproduce.
Registration

- When the paper goes through four press units, one for each color, it must be aligned exactly or the picture quality will suffer.

- The picture to the left is ‘out of register.’

- The press operator can adjust the position of each plate in with precision adjustment gears while the press is running at low speed. Pages are printed with color targets and density patches to aid in the process.
Virtually every kind of printing, where ink is applied to paper, uses the four-color process. This includes giant web presses and ink-jet printers.

All of these devices work the same way: Each of the four colors is applied separately in turn.

Our eyes “mix” the colors.
Look-up charts

- For a specific flat CMYK colors, designers turn to a lookup chart.
- It’s made up of squares with increasing percents of cyan, magenta and yellow. Sometimes black is added.
- These charts start with 20, 40, 60 and 80 percent yellow upper left.
- Cyan and magenta are added down and right, 10% at a time.
- Color lookup charts are printed on coated or uncoated paper, often on the press used for publication.
Pantone, DIC color

- Several companies offer color guides similar to the color chips found in paint stores. These include Pantone Color Matching and DIC, a Japanese company.

- The designer uses color guides to specify a spot or process color by number.

- Pantone is widely accepted by printers in the United States.
The color palette

- Designers never work with an unlimited number of colors. They build a palette of the colors they hope will be identified with the publication or product.

- In advertising, the color palette is important because it becomes tied closely with product identification. Colors are chosen for personality and for how well they work together.
Color palette and identity

- Choose your color palettes carefully, then use those colors consistently.
- Color is so closely tied to identity that a company such as IBM can come to be known as “Big Blue.”
- The yellow square around the National Geographic cover has become a trademark all by itself.
- The best color palettes have meaning beyond consistency. These palettes are chosen for mood, to convey meaning.

Choose your color palette carefully!
The University of St. Thomas specified this palette of colors that are allowed on its web pages.
McDonald’s color palette hasn’t changed in 50 years.
Color as information

Color provides layers of information, organizing complex graphics into something that is easy to follow. This London subway map uses colors coordinated with various train routes.
Another example of color as information
Color as experience
Color has a strong effect on personality and mood. No industry is more aware of how color affects us than the movie industry.
In order to use color effectively it is necessary to recognize that color deceives continually.

— Josef Albers
A color has many faces. One color can be made to look like two different colors.
- Albers says of this example, “It is almost unbelievable that the upper small and lower small squares are part of the same paper strip and therefore are the same color.”

- This is a phenomenon known as **color subtraction**. Don’t confuse it with “subtractive color.”

- What color subtraction means is that surrounding colors cancel out some of the colors of the smaller square.
Here, one color (the gray in the bars) appears as two. It takes on a yellowish tint on top of the violet and a violet tint on top of the yellow, the complimentary color of each.

Mario Garcia of the Poynter Institute calls gray the “chameleon” of colors. It takes on characteristics according to the colors surrounding it.
- Color contrast:
  When two contrasting colors are placed next to each other, one will move to the front, creating depth or dimension.

- Warm colors (reds, yellows, oranges) move to the front.

- Cool colors (blues, greens) fade to the back.

- This effect is extreme on a computer screen, where colors are more vivid than on the printed page. Here is an example using the primary hues of red and blue.
Color contrast: Warm and cool

The example from the previous page is so striking because it uses the “hot” and “cold” extremes of pure red and pure blue. Artists understand this principle and use it to emphasize some elements of a picture over others.
Color contrast: Light and dark

- Light and dark contrast of monochromatic or achromatic colors can add dimension to a composition.

- The gradation seen through the window frame progresses from 100 percent black at the top to white at the bottom.
Color contrast: Light and dark

- The window frame is one shade, a 50-percent gray.
- When the gradation is visible, the vertical bars of the frame appear lighter at the top and darker at the bottom.
- The top horizontal bar looks lightest, the middle darker and the bottom darkest.
Color contrast: Light and dark

- Painters achieve contrast using a limited choice of hues by adding black or white to the hue, creating **tints** and **shades** that express shadow and light.
- **Shades** are pure hues with black added.
- **Tints** are pure hues with white added.

Self portrait
Rembrandt

Rembrandt Harmenszoon van Rijn (1606-69) sketched his own image when he lacked other models.
**Color contrast: Saturation**

- **Saturation** is the amount of pure hue present. **Color interval**, the difference in saturation between two samples, can be judged by the borders.
- The red and blue squares become less saturated in a counterclockwise direction.
- The “hardest” edge is between the top two squares with the greatest interval.
- The bottom squares with the smallest interval have a soft edge.
Color contrast by saturation

By varying saturation, a painter adds depth to a two-dimensional work. Caillebotte used this to portray aerial perspective, in which objects far away appear lighter with a shift in color toward blue, and to give the street a wet, misty look.
Color contrast: Simultaneous contrast and transparency

- When two colors overlap with a third color mixed from various amounts of the other two, striking transparent effects are created.
- Each example is made up of three shapes: The brown and red rectangles have a third “cutout” shape that shows overlap. On the left, this “cutout” contains brown and red, but more of the brown, making the brown rectangle appear to be on top.
- In the example on the right, the cutout has more red than brown.
The illusion becomes apparent when we separate the parts of the composition.
Color contrast: Simultaneous contrast and transparency
The photorealist artists use simultaneous contrast to create paintings that trick the eye.
Color contrast: Proportion

- The eye is attracted to small amounts of saturated color on a duller background.
- The eye is attracted to these small spots of color like iron to a magnet.
Color contrast: Proportion

Color is related to hierarchy. Color can be used to make some things stand out. The trick is to stretch the color throughout the composition, creating a path for the eye to follow.

On the Terrace (1881)
Pierre-Auguste Renoir
Color contrast: Proportion
Color is related to hierarchy. Color can be used to make some things stand out. The trick is to stretch the color throughout the composition, creating a path for the eye to follow.

On the Terrace (1881)
Pierre-Auguste Renoir
The **Bezold Effect** is named after a German who noticed that certain strong colors, when evenly distributed, radically changed the effect of his rug designs.

Look at how different the red in the top wall looks compared with the red in the bottom wall. The red with the white looks much lighter than the red with the black.

But the red in both walls is exactly the same hue.
The Bezold Effect is important to keep in mind when using text on a color background. The red in both samples is exactly the same hue.
Definitions for using the color wheel:

- **Hue** – a pure color, any color except white or black (wide middle ring).
- **Tint** – a hue mixed with white (inner rings). Red (4) is a hue, pink (8) is a tint.
- **Shade** – a hue mixed with black (outer rings). Red (4) is a hue, maroon (1) is a shade.
- **Saturation** – intensity of the hue. Red (4) has higher saturation than pink (7).
- **Brightness or Value** – the lightness of a hue. Pink (7) has a higher value than red (4).
A designer finds discipline in using color by adopting a systematic way of choosing a color palette.

The color wheel is composed of **12 basic hues**: three primaries, three secondaries and six tertiaries.

- **Primary colors** – Red (4), blue (68) and yellow (36) cannot be made by mixing other colors.

- **Secondary colors** – orange (20), green (52) and purple (84) are made by mixing two primary colors.
- **Tertiary colors** – red-orange (12), yellow-orange (28), yellow-green (44), blue-green (60), blue-violet (76) and red-violet (92) are made by mixing a primary color with a secondary color.

- **Complementary colors** – Two colors opposite each other are complementary. When mixed, two complementary colors will form a neutral.
- Pure high-chroma **hues** appear in the wider center ring: 4, 12, 20, 28, 36, 44, 52, 60, 68, 76, 84 and 92.
- Colors on the inner four rings are **tints** made by adding white to the pure hue.
Colors on the four outer rings are **shades**, made by adding black to the pure hues.
Cold colors
Think of ice, with its blue, blue-green and green. These colors have the effect slowing the metabolism, making people feel cooler. Cold colors can be austere or refreshing.
Hot colors

- Highly saturated red is the essence of fire. Red has been proved to stimulate the body. Red also is associated with passion. It’s the color that is retained on the retina the longest, and it instantly attracts the eye.

- Learn how to use red and the rest of the colors are easy. Painters such as Renoir knew that using small spots of red created movement in otherwise static pictures.
Light colors
With only the faintest hint of a hue, these colors on the innermost ring of the color wheel reflect light and make a room, photograph or painting seem to glow. Light colors open up space.
Dark colors
These strong, somber colors constrict space rather than expand it. Dark colors often are used in interior design for contrast. They can convey moods ranging from dignified and traditional to melancholy.
Warm colors
These colors are based on red but with yellow added to soften the fire. These colors are inviting, much like the comfort of a fireplace. Warm colors show up in interior design.
Cool colors

Just as warm colors are based on red, cool colors are based on blue but blended with red or yellow, producing a range of colors from light blue-green to violet. Cool colors are considered peaceful and meditative, calming.
Pale colors

- Pale colors are tints — hues softened with a substantial amount of white. These pastels evoke softness, youth and innocence.

- These colors on the inner ring of the color wheel are considered feminine and often are used in cosmetic packaging.
Earth tones

Earth tones take their cues from the environment, making use of neutrals with shades of green. Earth tones have replaced pale colors in many cosmetics aimed at environmentally conscious consumers.
Bright colors
Distinctive highly saturated colors — with little or no white or black — are so intense they can seem to vibrate. Bright colors, a trademark of Pop Art in the ’60s, are used in products aimed at children.
Achromatic colors
Gray is at the center of an achromatic color scheme. Gray is a serious, sober, no nonsense neutral that communicates strength and industry. An achromatic palette makes a background that allows any color present to take on added impact.
How to combine colors

Basic color schemes have a mathematical perfection in them, but they still rely on objective judgment in how appropriate they are for a given use. Complementary colors always are opposite each other and will always intensify each other. Here are the basic schemes:

**Complementary.** This scheme uses direct opposites on the color wheel: red/green, blue/orange and yellow/purple. These colors enhance each other and almost seem to vibrate when side by side.

<table>
<thead>
<tr>
<th>100%</th>
<th>50%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>50%</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Achromatic.** It means “without color.” This scheme uses black and white and a range of grays.

<table>
<thead>
<tr>
<th>92</th>
<th>88</th>
<th>73</th>
</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>88</td>
<td>73</td>
</tr>
</tbody>
</table>

**Analogous.** Any three hues next to each other on the wheel, including their tints and shades, are Analogous. They have a harmonious, pleasing effect on the eye.

<table>
<thead>
<tr>
<th>92</th>
<th>44</th>
</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>44</td>
</tr>
</tbody>
</table>

**Clash.** Clash color schemes have a brash surprising effect. To create these, combine a hue with the color found on either side of its complement, such as blue with red-orange or orange-yellow.

**Complementary.** This scheme uses direct opposites on the color wheel: red/green, blue/orange and yellow/purple. These colors enhance each other and almost seem to vibrate when side by side.
Neutral. Colors so soft that they blend in to the point of being invisible. These are hues neutralized by adding their complements, further expanded by adding white or black.

Monochromatic. This restrained, peaceful color scheme, recently in vogue for men’s clothing, is a single slice of the color wheel pie: one hue with its tints and shades.

Primary. The most basic color scheme: red, yellow and blue. The elementary nature of this scheme make it a favorite for children’s toys and books. The purity of this scheme made it the favorite of artists such as Piet Mondrian and Roy Lichtenstein.

Secondary. It combines secondary hues of green, purple and orange. It has a fresh, uplifting quality and can be made subtle by using tints and shades.
Split complementary — This scheme often is found more pleasing than true complementary colors. Choose a hue; the hues on either side of its complement create the split complementary scheme.

Tertiary triads — The color wheel has two tertiary triads, each consisting of tertiary colors that are equal distance apart: red-violet, yellow-orange and blue-green, and red-orange, yellow-green and blue-violet.
A test

Look at the images on each of the following pages.

■ Write down one word that describes how the colors make you feel.

■ Write down one word that describes the color scheme (such as bright, sexy, rich, classic).
URBAN
GET A LIFE STYLE
PRESENTS: TOP 10!

10 BEST WINES
10 BEST DIETS
DO YOU WANT TO KNOW WHAT'S UP DUDE?

10 BEST INNER TOURS
ALL YOU NEED TO KNOW AND YOU HAD NO ONE TO ASK...

10 BEST BOUTIQUE HOTELS
ALL YOU HAVE TO HAVE BUT YOU JUST DIDN'T KNOW YOU HAD TO HAVE IT!

10 BEST ACCESSORIES
ALL YOU WANT TO BUY AND YOU SHOULD SAVE MONEY TO

10 VERY SPECIAL
REALY NEED TO REALLY KNOW

10 BEST WAYS
TO IMPROVE YOURSELF!

10 BEST
AUDIO/VIDEO
ALL THE THINGS YOU HAD NO IDEA THAT ARE RIGHT HERE

10 VERY BEST

10 BEST
DESIGN TRENDS
DO YOU LOVE YOURSELF? EXCELLENT! NOW GET OUT AND SHOW IT TO THE WORLD

10 BEST
COSMETIC PRODUCTS
INSIDE IS THE JOY AND HAPPINESS OF KNOWING YOU HAVE THE VERY BEST!

10 BEST
APPLIANCES & MUCH MORE...