UNIT - I - ORIGINALS & COLOUR

1.1. ORIGINALS

Any copy whether it is a mechanical, artwork or other material from which reproductions are to be made is called as a Original. Original is a term which can include camera ready artwork, drawings, paintings, photographs, transparencies, black-and white or colour prints and even three-dimensional objects. The term original commonly refers to photographs used for haftones or to original line art.

Types of Originals

There are two types of originals:

1. Reflection Originals and
2. Transmission Originals

1. Reflection Originals

Any original copy which is to be reproduced that exists on an opaque substrate (such as photographic print) is called as Reflection Original. Reflection Originals must be scanned by reflecting light from their surface. Photographic color prints, paintings, wash drawings are termed reflection originals.

2. Transmission Originals

Any original copy which is to be reproduced that exists on a transparent substrate (such as photographic transparency) is called as Transmission Original. Transmission Originals must be scanned by transmitting light through their surface. Color transparencies are termed as transmission originals.

1.2. CLASSIFICATION OF ORIGINALS

The process of graphic reproduction, whether through traditional or digital means, starts with an assessment of originals. Originals may be monochrome, for single-colour reproduction, or colored for multi-coloured reproduction.

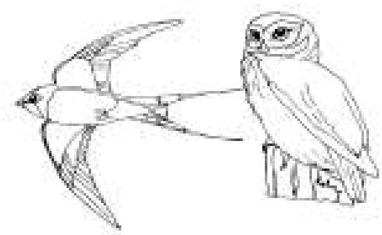
Originals can be further classified as follows:

1. Line originals.
2. Tone or Continuous Tone originals.
3. Color originals.
4. Halftone originals.
5. Merchandise Samples.

1. Line originals

Line originals have no gradation of tone - that is, they possess no intermediate tones. The image is produced by clear distinct lines, or other shapes of uniformly solid areas. Text or artwork containing no tonal values or shades of gray and which can be imaged and printed without the need for halftone screens are called as line originals.

Examples of line originals include: paper paste-up from phototypesetters, typewritten or laser-printed line copy, dry transfer lettering; pen and ink effect drawings (in black ink on white paper or board): or their digital equivalent, produced electronically as described previously, using a word processing or similar based program, also draw or paint software program on a host computer system



Line Original

TYPES OF LINE ORIGINALS

i) Monochrome line originals

Line originals prepared for single color are called as monochrome line originals. Typical examples of monochrome originals are technical drawings, figure drawings, architectural plans, etc.

When produced traditionally, it was generally accepted that flat artwork should be prepared in a size larger than that of the finished size, probably 1.5 to 2 times, as photographic reduction gave a sharper result and any minor irregularities tended to be lost. Excessive reduction if required should be avoided, since this causes loss - of details. For example, fine lines can fill in on thin type reversed out of a solid area.

At present line originals are reproduced using graphic software packages and/ or word processing software, which allow relatively simple and Straightforward graphic forms to be created: an alternative is the use of clipart or similar systems. These software packages allow the operator to view originals on screen, at for example 200% and 400%, and thus ensure at least relatively fine definition and correct butting up of line edges, etc. These can then be checked and adjusted, so that when reproduced at the correct size, the desired results are achieved without visible imperfections.

ii) Colour line originals

Line illustrations may be produced for printing in two, three, four or more colours, with a separate colour split for each colour are called as color line originals.

Different techniques are used to isolate, or separate, the original into the required number of colours. Traditionally, using flat artwork, this would take the form of a coloured original, or a key drawing with the different colour areas indicated on an overlay or series of overlays. In computer-generated illustrations, the illustrator/operator will simply highlight or mask off the coloured original by use of the cursor, or pressure pen and pad system, tracing around the required areas, and instructing the software program in use to split for colour as requested.

2. Continuous Tone Originals

Continuous tone originals, consist of a variety of gradations between highlights (lightest areas), mid tones (neutral/mid-way areas) and solids (darkest areas).

Tone originals may be,

1. Monochrome Tone Originals (eg. Black and White Photographs)
2. Color Tone Originals (eg. Color Transparencies, Color Prints or Color artwork)

Continuous tone is a photographic image that is not composed of halftone dots, or in other words, an image that consists of tone values ranging from some minimum density (such as white area) to maximum density (such as dark area). An example of a continuous tone image is a photograph or a color transparency.

Other examples of continuous tone originals include: photographic prints and transparencies: plus wash drawings, pencil, charcoal and crayon sketches - all of which are increasingly prepared and reproduced by electronic means.

Continuous Tone Originals

Transparencies are still one of the most popular mediums for colour reproduction of continuous tone originals, although digital media such as Photo CD and digital picture libraries are increasing in popularity and use. Ideally, transparencies should be sharp and with a fine grain structure - that is, free from excessive grain - without colour bias or cast, and with good tonal and density range (from 1.8 to 2.8).

Photographic colour prints, paintings, wash drawings and the like, are termed reflection copy. If they are to be reproduced on a colour scanner, ideally they should be of an overall size small enough to fit comfortably on the desktop flatbed platen or drum scanner's analyse unit; and flexible enough to bend, when a drum scanner is used. Cleanliness in handling continuous tone originals is even more important than in line originals because smudges and stains, like tones, will be reproduced.

Originals with uneven surfaces, such as drawings or paintings on heavy grained paper, board or canvas, require careful lighting and in such cases it is often worth getting a commercial photographer to produce a transparency or photograph, which will constitute a more suitable original for reproduction.

3. Color Originals

Pictures representing line and tone in color are called color originals. Eg: Color Transparencies, Color Prints, Color Paintings, Color Line Drawings. The type of original used for a given purpose depends upon the degree of realism or abstraction desired by the designer. Photographs are generally preferred when a high degree of realism is required. The more abstract design usually employs hand- drawn artwork, although some photographs also can be used for this purpose. For the ultimate in realism, the actual object or piece of merchandise may be submitted for use as an original.

Figure: Photographic originals: (A) 4x5-inch color transparency; (B) 35-mm color negative; (C) 35 mm color transparency.

i) Photographic Color Prints

The Photographic color print is commonly used for reflective color reproduction originals. One form of this material consists of a paper base that is coated with red, green, and blue-sensitive layers that form, during processing, cyan, magenta, and yellow dye layers. This is known as the dye coupling process. Depending on the film type and the processing technique, tripack materials can be used to make prints from color negatives, color transparencies, or directly from the original scene in the case of “instant” photography. The dye bleach process, on the other hand, consists of predyed emulsion layers that are selectively removed in processing. The prints can be made only from transparencies in this process.

One possible problem that can be encountered when reproducing color prints is due to the fluorescence of the substrate, a factor that can affect the reproduction of light tones. Substrate fluorescence can be countered by mounting UV absorbers over the illuminating light source.

It may be desirable to use prints instead of transparencies when the photographer has no control over the lighting of the original scene. It is possible to make adjustments when making the color print in order to make it conform more closely to the desired appearance. The print is, furthermore, a reflection original with a contrast range and gamut close to the photo mechanical printing processes. Such originals are, therefore, generally easy to match. Customer comparisons of original to reproduction are relatively uncomplicated when color prints have been supplied.

ii) Photographic Color Transparencies

Color transparency films all have integral tripack types of emulsions coated onto film bases. Unlike photographic print materials, color transparency materials vary greatly in terms of resolution, sharpness, graininess, speed, and color rendition. In general, the lower the speed the higher the image quality.

The creative demands of the job may determine the color transparency format. Large-format 8XI0-inch. (20X25-cm) cameras cannot be used satisfactorily for high- speed action photography. The 35-mm camera with its light weight and motor drive is preferred in these situations. On the other hand, 35-mm cameras are not suitable for architectural photography. The swings and tilts of large-format cameras must be used to overcome the converging parallels common with 35-mm and other fixed plane cameras.

Films that are designed for viewing by projection in a darkened room, such as 35-mm transparencies, tend to have a higher-contrast range than sheet film transparencies. All transparency materials, however, have a range greater than 3.0 optical density. Each individual color film distorts the original colors in its own way. No one color film can be selected as the best for all photographic assignments, but whenever possible, the same fIlm should be used throughout a given job.

Transparencies have several advantages over prints. Higher resolution, higher sharpness, and the ability to wrap around a scanner drum (a factor if supplied prints are mounted on a rigid base) are the more important factors.

iii) Artist's Color Originals / Paintings

Artist's originals exist either as fine art, which is created with no thought of reproduction, or as commercial art, which is created specifically to be reproduced. A wide varies of artist's mediums is available as a carrier and binder for the pigments.

The medium chosen to produce a given piece of art depends upon the creative intent of the artist. Certain materials convey a particular mood, sensation, or color more successfully than other materials. Some problems may arise, however, when trying to reproduce artwork that has been prepared using a given technique.

The heavy intensities and saturations of oil paintings may be difficult to reproduce. Especially if there is a lot of dark shadow detail. The clear, light colors of pastels also may cause problems in reproduction, especially when coarser halftone screens are used. Extra colors may have to be used to achieve satisfactory reproductions.

Nongamut colors should not exist in commercial artwork. The graphic artist or designer should understand the gamut restrictions of average process inks on coated and uncoated papers. The colors that are selected for the artwork in question must fall within the range that is reproducible by the production conditions. If some colors outside the gamut are chosen, these colors will be reproduced at lower saturation. Those other colors within the gamut will be reproduced correctly; therefore, with some correct and some incorrect colors in the final reproduction, the designer's original intent becomes distorted.

Figure: Fine art originals may contain colors that fall outside the color gamut of the reproduction system.

4. Halftone Originals

Originals in which detail and tone values are represented by a series of evenly spaced dots of varying size and shape, the dot areas varying in direct proportion to the intensity of the tones they represent are called as halftone originals.

i. Black-and-White Halftone Originals

A black-and-white halftone original consists of a pattern of black dots of various sizes that represent tones of gray. Examples of halftone originals are printed pictures in newspapers or magazines. Small dots with ample white space between them produce an illusion of a light tone or highlight. Large dots that are close together produce the illusion of dark tones or shadow areas. Because the dots are all the same tone (black), halftone originals can be copied as line originals. This type of original can also be copied as a continuous-tone original, depending on the use of the final product.

ii. Color Halftone Originals

Color photographs printed in magazines, newspapers, or books consist of a series of dots in cyan, magenta, yellow, and black (CMYK) that fool the eye into seeing the millions of colors that make up the original image.

iii. Digital Halftones

When using scanned images or images from a digital camera, you can produce digital halftones direct from the software to the printer. Digital halftoning depends on the lpi (lines per inch, or screen frequency) and the resolution of your output device (printer). The screen used may be specified in your printers PPD (PostScript Printer Driver) or set specifically in your software program.

5. Merchandise (Product) Samples

In those cases where a very accurate color match is required, an actual sample of the product is sometimes supplied for use as an original. Examples are paint chips, fabric swatches, linoleum squares, or upholstery samples.

HANDLING OF ORIGINALS

- Any dust, finger marks, scratches, or other defects on an original have to be avoided during the reproduction, as they will be magnified during printing.
- Care should be taken in handling all originals, preferably keeping them in mounts or sleeves except when they are being scanned.

- A quick wipe over the surface of an original before scanning can save a great deal of time pixel cloning later in an image-editing program.
- On some scanners , transparencies are mounted in oil to improve the contact with the scanner drum and reduce the likelihood of scratches and Newton's rings appearing on the scanned image. If scratches or other marks appear on an image they can be removed in an image-editing application

Other requirements of good originals include good tonal gradation and good tonal separation between areas of detail (bearing in mind that this tonal separation will be compressed when the image is scanned).

1.3. LIGHT AND COLOR

To understand the process of color reproduction, it is first necessary to gain an appreciation of the phenomenon of color. To do this, we must examine the nature of light, without which color would not exist.

What is Light?

Light is radiant energy that is visible to the average human eye. For the purposes of this discussion it can be assumed that light travels in wave motion, with the color of light varying according to the length of the wave. The wavelengths can be measured and classified along with other forms of energy on the electromagnetic or energy spectrum. Light can either be a wave as was first proposed by Christian Huygens, or as a series of discrete particles as was first proposed by Sir Isaac Newton. Eventually it was decided that light could be both a wave and a series of particles.

The intensity (or luminosity) of a light source is measured in candles. The intensity of light reflected from a surface (or luminance) is measured in candles per square meter, or foot candles or foot lamberts.

What is color?

The term color refers to the quality of light possessing certain dominant wavelengths.

Color is a complex visual sensation that is influenced by the physical properties of the illuminant and sample, but it is determined largerly by the physiological characteristics of the individual observer. Insights into the process of color perception may be gained through examinations of these distinct elements (illuminant, sample, human observer) and the manner in which they interact.

Color is an optical phenomenon, a sensory impression conveyed by the eye and the brain. Light reflected or transmitted by an object is received by our eyes and transformed into nervous impulses, which trigger the colour sensation in our brain. Color is not a physical variable, accordingly it has no physical unit. An object is not colored, but the sensation of color is produced as a result of irradiation by light, Sunlight, which appears to be white, radiates on to an object and is partially reflected. Consequently an object that reflects the red area of the spectrum appears colored. An object that reflects completely in the entire visible spectrum usually appears to be white and a completely absorbent body appears to be black.

When perceiving and describing colors, physical and physiological effects are always involved. The physical components are measurable, where as the physiological components are not measurable.

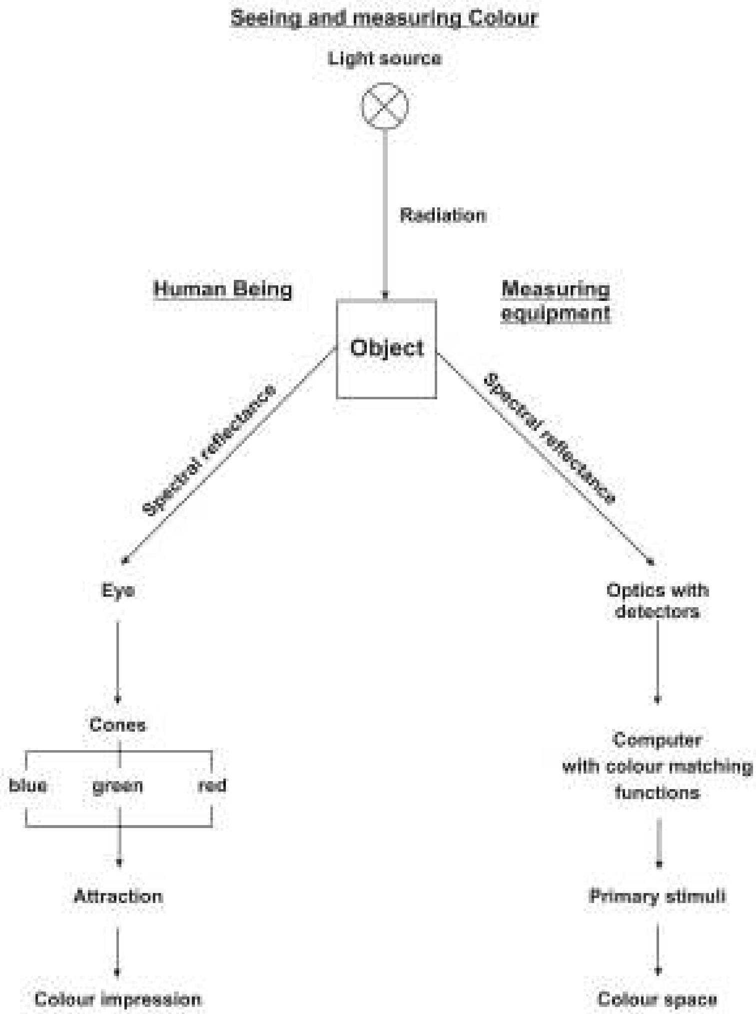
The mixing of certain basic colors produces all of the colors we can perceive. There are three categories of colors: *primary colors, secondary colors,* and *tertiary colors.* Primary colors are those that are not formed by mixing of any other colors and can be said to be “pure” colors. Secondary colors are those formed by the mixing of two or more primary colors. Tertiary colors are those produced by mixing of two or more secondary colors. What constitutes a primary color differs depending on whether one is talking about light or pigments.

Interestingly, according to Hope and Walch in *The Color Compendium,* polls have consistently found that in Western Europe and North America over half of the adults surveyed name “blue” as their favorite color, while children under eight consistently name “red” as their favorite. (In Japan, however, over half of the people surveyed named either white or black as their favorite color).

Color preferences tend to vary by culture, not unexpectedly. This may seem like a trivial matter, but it is an important consideration in planning multinational advertising campaigns, designing products such as clothing for other markets, and other such endeavors. It also manifests itself in appropriate dress when visiting other cultures; white is not universally accepted as the bride’s dress color at a wedding, for example, nor is black universally appropriate for funerals or other mourning rites. In other words, color is a cultural specific concept; various colors are symbolic of different things, and these symbols are not universally consistent.

Seeing and Measuring Colors

Here, the biological vision of human beings is contrasted with the process of physical measurement, as performed by a measuring system. Light falls on a sample. The sample absorbs part of the light, while the rest is reflected or re-emitted as diffused radiation.



We perceive this re-emitted light with our, eyes. In the process of seeing, cones in the retinas of our eyes are stimulated. Different cones are sensitive to blue, green, and red. The stimuli are transformed into excited states, in turn, causing signals to be sent along the optic nerve to the brain, which interprets them as colour.

This same process can be emulated in a measuring instrument. One such measuring instrument is the spectrophotometer. Of course, a measuring instrument cannot actually perceive anything, but it is able to perform calculations on predefined and measured values.

Thus, during the measuring process light also falls on the printed sample. The reflected light, also known as spectral reflectance, passes through a series of lenses to strike a detector. This then relays the values it registers to the computer. There, digital filters that simulate the visual sensitivity of our eyes are used to calculate values, referred to as standard stimuli, or tristimulus values.

The standard stimuli are equivalent to the excitation of cones in our eyes. These tristimulus values are then converted and mapped onto a colorimetric system. With the aid of the figures thus determined, a colour can be precisely described and compared with other colors. This, in very simplistic terms, is the measurement principle underlying a colorimetric instrument.

Principles of colour

Colour is a very complex issue and there are many factors which need to be considered in order to understand how we perceive and reproduce it.

Colour as a wavelength

We can see the visible wavelengths between 380 and 760nm (one nanometre equals one millionth of a millimeter). If one particular wavelength dominates or, more specifically, the spectral power distribution is unequal we see a particular colour - if there is a balanced distribution of all wavelengths we see white or gray - i.e. - neutral. Light with a wavelength of 380nm appears as violet, 760nm ‘as red and 570nm as green. Colour, as we know it, can be in the form of a ‘physical’ solid, such as printing ink or colored toner; or in the form of an energy light source, such as with a TV or computer colour monitor.

The human perception of colour

The sensation of colour is the effect of light upon the eye interpreted by the brain. White light is composed of a mixture of all colours of the rainbow or spectrum, and most objects are visible by the light reflected or transmitted from them, depending upon whether the object is opaque or transparent. The colors of the visible spectrum include (in order of increasing wavelength) violet, indigo, blue, green, yellow, orange and red.

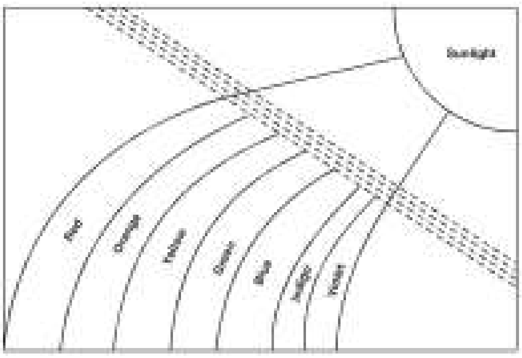


Figure: White light is composed of all the colours of the rainbow / visible spectrum

White light appears to have no color because all the wavelengths are present in equal amounts, effectively “cancelling” each other out. Objects appear colored because they reflect or transmit some parts of the spectrum and absorb the others. For example, a red object appears red as it reflects the red light and absorbs most of the violet, blue, green and yellow lights. White objects reflect or transmit almost all parts of the spectrum, while tones of gray absorb equal proportions of all its constituents and black absorbs almost the whole of it.

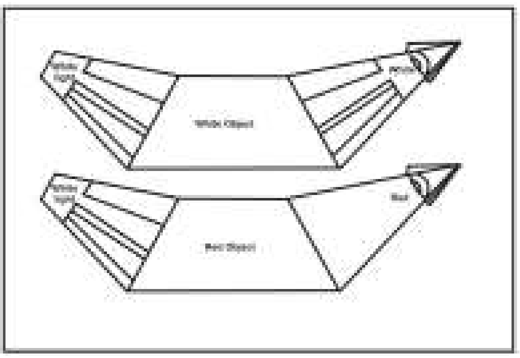


Figure: How different coloured objects filter out and reflect different colours - thus a red object reflects only red

The perception or sensation of color, despite attempts to objectively quantity it, is a highly subjective phenomenon. We speak of, for example, a “red apple,” but the redness of the apple is more dependent on our own peculiar visual systems than any inherent “redness” in the apple. (To organisms with different types of photoreceptors, it could appear to possess a much different color.) Even among different humans, the redness perceived is not absolute, varying according to minute physiological differences in visual acuity or according to the illumination used.

1.4. THE PROPERTIES OF COLOUR

The ***co*lorimetric properties** of color are those that describe its three dimensions: *hue, saturation,* and *lightness.*

Hue

- **Hue** is the name given to a specific colour, to differentiate it from any other.The hues blue, green and red; yellow, magenta and cyan form the familiar colour wheel- see Figure Color Wheel.

The **hue** identifies whether a color is red, blue, green, yellow, or some combination term as greenish yellow or bluish red. Such other terms as magenta or crimson are often used as hue names. Hue may have an infinite number of steps, or variations, within a color circle. A circle displays all the hues that exist; indeed, it can be said that any reproduction process is capable of matching any given hue.

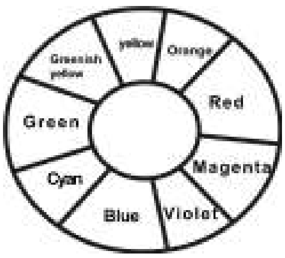


Figure: The hue component of color shown on an abridged color circle. The divisions are illustrative. The circle is a modified version of a structure suggested by Frederick T. Simon.

Saturation

- **Saturation**, similar to **chroma**, indicates the purity of a colour. It refers to the strength of a colour, - i.e. - how far it is from neutral gray.

A gray-green, for example, has low saturation, whereas an emerald green has higher saturation. A color gets purer or more saturated as it gets less gray. In practice this means that there are fewer contaminants of the opposite hue present in a given color. To illustrate this concept, imagine mixing some magenta pigment with a green pigment (the opposite hue). The green will become less and less saturated until eventually a neutral gray will be produced. A gray scale has zero saturation. The figure below shows the magenta-green saturation continum. Magenta becomes desaturated by the addition of green in the same way green becomes desaturated by the addition of magenta.

As a color becomes less saturated, it is said to be dirtier or duller, and as it becomes more saturated, it is described as cleaner or brighter. There is a limit to how desaturated a color can be (it will always reach neutral gray) and there are practical limits in reproduction processes to how saturated a color may appear. These practical limitations in printing are due to the characteristics of the chosen ink-substrate combination.

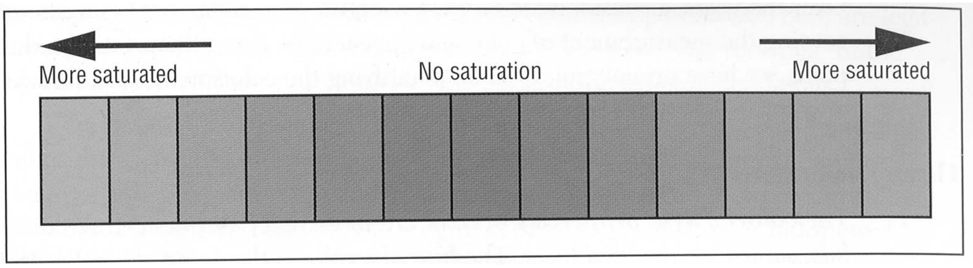
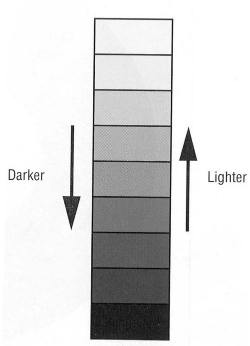


Figure: The saturation component of color for the magenta-green hue axis.

Brightness / Lightness

- **Brightness**, similar to **lightness, luminance** or **value**, describes how light or dark a colour is, indicating whether a colour is closer to white or to black: brightness does not affect the hue or saturation of a colour. Grey is a neutral 'colour' between white and black - to lighten a colour the brightness or lightness element is changed.

In fact, the terms lightness and darkness are synonymous. Lightness or darkness of a solid color may be changed by mixing either white or black ink with the color. In process-color printing this is achieved by printing a color at various halftone percentages from 0 to 100 (mixing with white), then overprinting the 100% solids with increasing percentages of black (mixing with black). The figure below shows the lightness aspect of color.



In practice both lightness and darkness have limits. In printing, the lightness of a color is limited by the properties of the substrate. It is generally possible, for example, to achieve lighter colors on a good coated paper than on newsprint or uncoated recycled paper. The darkness of a printed color is limited by the gloss of the substrate and the ink, and the amount of ink (and pigment) that can be physically transferred to the substrate. Drying, trapping, dot spread, and economic factors restrict the thickness and number of ink films that can be sequentially printed.

- **Neutral colours** do not possess the properties of hue or saturation but are described according to their lightness - white, black and gray are neutral ‘colours’.

Violet	Cyan 0%	0% Gray
Green	Very Light Blue (Cyan 25%)	Light Gray (25 % Gray)
Red	Lighter Blue (Cyan 50%)	Gray (50% Gray)
Yellow	Blue (Cyan 100%)	Black (Black 100%)
Hue	Saturation	Brightness

Table: Variations of hue, saturation and lightness

A simplified illustration of how hue, saturation and lightness operates is shown opposite:

- four different hues or colours - yellow, red, green and blue
- four different saturations of one colour -cyan as 100%,50%,25% and 0%
- four different levels of lightness - black,50% gray, 25% gray and pure white

- **Neutral subtractive ‘colour’** - when yellow, magenta and cyan printing inks or toners are present in equal amounts, the coloured result appears gray or black.
- **Neutral additive ‘colour’** - when blue, green and red lights are present in equal amounts, the colored result appears gray or white.
- **Opposite colour pairs** - colours which appear opposite to each other when combined together, form a ‘neutral’ colour - e.g:’ red + cyan, green + magenta, yellow + blue (blue/violet).

Reproduced below is a colour wheel, showing the additive primary colours of blue, green and red as well as the subtractive primary colours of yellow, magenta and cyan - note blue, green and red; yellow, magenta and cyan appear opposite to each other on the colour wheel.

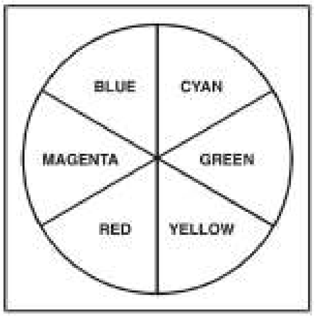
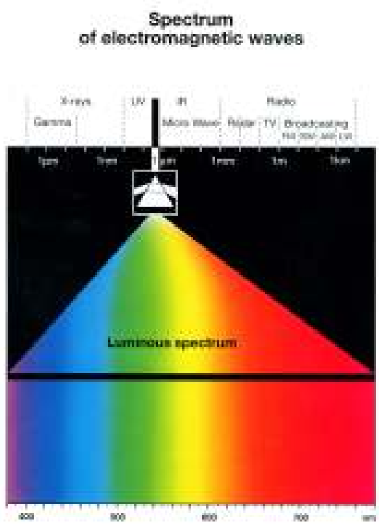


Figure: Colour wheel illustrating blue, green, red, plus yellow, magenta, cyan and their relationship/position to each other on the wheel

1.5. THE ELECTROMAGNETIC SPECTRUM

Of the overall spectrum of electromagnetic waves, the human eye is only able to perceive a narrow band between 380 and 780 nanometers (nm). This visible spectrum is situated between, ultraviolet and infrared light. If the light of this visible range is passed through a prism, then the individual spectral colors can be seen.

However, light is not absolute. For example, if a printed image is compared with a proof under artificial light, the two may seem identical, but regarded in daylight, differences may suddenly appear.



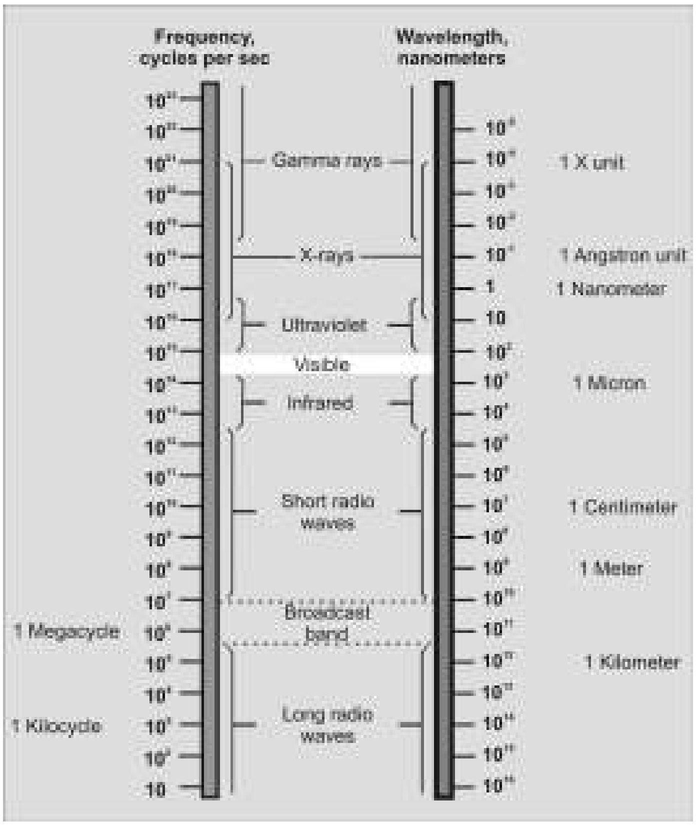
Wave length (in Nanometers)

The Visible Spectrum

Light is a small portion of the much larger *electromagnetic spectrum,* a broad range of different types of generated energy, ranging from radio waves and electrical oscillations, through microwaves, infrared, the visible spectrum, ultraviolet radiation, gamma rays, and high-energy cosmic rays. All of these sources of electromagnetic radiation exist as waves, and it is the variations in wavelength and frequency that determine the precise nature of the energy.

These wavelengths range in size from many meters (such as radio waves) to many billionths of a meter (gamma and cosmic rays). Visible light is technically defined as electromagnetic radiation having a wavelength between approximately 400 and 780 *nanometers* (one nanometer is equal to one billionth of a meter).

The electromagnetic spectrum ranges from the extremely short waves of gamma rays emitted by certain radioactive materials to the radio waves, the longest of which can be miles in length. Light, the visible spectrum, ranges from about 400 to 700 nm (nanometers, or billionths of a meter) in length. Some sources suggest that the visible spectrum could range from about 380 to 770 nm, but the exact limits will depend on the visual system of a given observer. Below 400 nm are the ultraviolet rays, which are important when dealing with fluorescent materials. Above 700 nm are the infrared rays, which have significance in certain kinds of photography or image capture.



The visible spectrum occurs in nature as a rainbow. It can be duplicated in a laboratory by passing a narrow beam of white light through a glass prism. The spectrum appears to be divided into three broad bands of color-blue, green, and red-but in fact is made up of a large number of colors with infinitesimal variations between 400 and 700 nm. The colors in the spectrum are physically the purest colors possible. The splitting of white light into the visible spectrum, and the recombining of the spectrum to form white light, was first demonstrated and reported by the English scientist Sir Isaac Newton in 1704.

The reason that a spectrum can be formed by passing white light through a prism has to do with the refraction of light as it passes from one medium (air) to another(glass).The prism bends light of the shorter wavelengths more than light of the longer wavwlengths, thus speading the light out into the visible spectrum. In nature, drops of rain act in a manner similar to that of a prism: when a beam of sunlight breaks through the clouds it is refracted by by moisture in the air and a rainbow is formed.

Color Reproduction Principles

Color Reproduction Terminology

Color reproduction is the process of making color images of an original scene or object. Generally speaking, it involves the use of an optical system, a light-sensitive material, an image processing method, and an electronic or colorant-based rendition system.

In the case of the printing industry, the process typically involves making reproductions from existing photographs or artists' originals. Electronic camera images also are commonly used as the starting point for the printed color reproduction process.

Originals in full colour, such as transparencies and colour photographs, are mainly reproduced by four-colour process, using yellow, magenta, cyan and black printing inks. A separate screened negative/positive, printing 'plate, cylinder or stencil is required for each colour, so that the printing combination of colours reproduce the full effect of the original. For the most faithful reproduction possible, special colours may be necessary, particularly in packaging and labels, where they may be used for overall solids or house colours. These are often specified as a PANTONE Matching System (PMS) reference.

There are two types of colour reproduction - 1. Additive Color Theory.
2. Subtractive Color Theory.

Photomechanical color reproduction is the traditional term that describes the printing industry's color reproduction production process. This process may include the production of intermediate film, plate, or cylinder images prior to the stage when the colorants are physically transferred to a substrate. Some of the processes used by the industry form the image directly from digital data without the need for intermediate film or plates.

The yellow, magenta, and cyan subtractive primaries, plus black, that are used for making printed color reproductions are known as **process colors**. The term **process color printing** is often used to mean photomechanical color reproduction, but it also means the production of flat color tones by combined process colors.

The term **color printing** is a broad one that includes flat solid color (nonpictorial) package printing and fine art printmaking, as well as the photomechanical color reproduction process. Color printing may also be used to describe the production of photographic color prints or the generation of output from computer-driven desktop color imaging systems.

Additive Color Theory

As previously mentioned it is possible to divide the spectrum of white light into three broad bands - blue/violet, green/yellow and orange/red - which appear essentially blue, green. and red to the eye: these are in effect the additive primary colours. If these colours, in the form of beams of coloured light, are in similar proportions upon a white screen then white light is created. With the overlapping primary colours of blue, green and red, the secondary colours of yellow, magenta and cyan are produced.

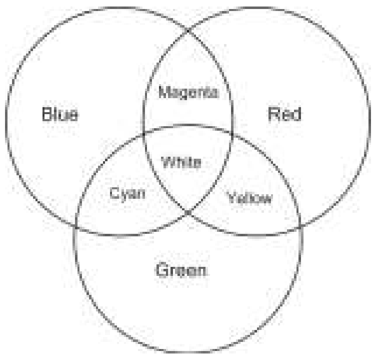


Figure: Principles of additive color theory - the three broadbands of the spectrum can be mixed to make a variety of colours

An additive mixture of colours is a superimposition of light composed of different colours. If all colours of the spectrum are added together, the colour white results. Red, green and blue are the additive primary colours. They are called one-third colors because each represents one third of the visible spectrum. The additive system starts with darkness (for example, a blank TV screen) and adds red, green and blue to achieve white.

Green + Blue	= Cyan
Red + Blue	= Magenta
Red + Green	= Yellow
Red + Green + Blue	= White
No Light	= Black

Table: Additive color combination.

The principle of additive color mixture is used in color TV and in the theaters to produce all the colors of the visible spectrum.

When wavelengths of light are combined or added in unequal proportions, we perceive new colors. This is the foundation of the **additive color reproduction process.** The primary colors of the process are red, green, and blue light.

Secondary additive colors are created by adding any two primaries:

- red and green combine to produce yellow;
- red and blue combine to produce magenta; and
- blue and green combine to produce cyan.
- The presence of all three colors will produce white, and
- the absence of all three colors will result in black.

Varying the intensity of any or all of the three primaries will produce a continuous shading of color between the limits.

Two methods for adding colors may be used: (i) red, green, and blue-light image records either overlap each other, or (ii) are placed side by side within a mosaic structure. The overlapping-primaries method of additive color reproduction has certain practical limitations that restrict its use. The side-by-side red, green, blue image element approach to additive color reproduction has, however, proved to be quite successful for certain applications.

Color television works on this basis: a magnifying glass will reveal the red, green, and blue mosaic structure of the screen (figure below). Many early color photography processes were also based upon the mosaic-structure type of additive color reproduction.

Additive color photography processes, however, have certain disadvantages when compared to subtractive methods. The drawbacks of the additive color reproduction photographic process are due to the fact that the red, green, and blue-filter mosaic absorbs two thirds of the light in the whitest areas. Additive-process transparency photographs appear to have low contrast and saturation unless they are viewed using a relatively intense light within a darkened room.

Satisfactory reflection color photographs and color printing cannot be produced by the additive process. Red, green, and blue rotating reflection disks are often used to demonstrate the principles of additive color reproduction, but it is necessary to illuminate the disk with an extremely intense light to achieve satisfactory results.

The additive color reproduction process works for television and computer-monitor imaging processes because the intensity of the self-luminous display screen is sufficient to overcome the room lighting effects. For best results, however, television and monitor displays should be viewed under dim ambient lighting conditions, and the viewing distance must be sufficiently great so that the eye cannot resolve the mosaic structure of the screen.

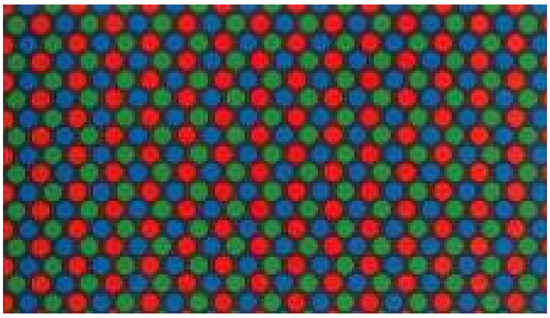


Figure: The red-, green-, and blue-filter mosaic of a color television screen. Separate elements are fused into a continuous color at the appropriate viewing distance

Subtractive Color Theory

The limitations of the additive process for reflective light viewing can be overcome with the **subtractive color reproduction process**. The subtractive system starts with white (white paper illuminated by white light, for example) and subtracts red, green, and blue to achieve black.

The majority of commercial work is printed in four, rather than three colours, adding black to the process set. Black Color is included to compensate for deficiencies in the yellow, magenta and cyan pigments, and to allow type to print in only one dense, high contrast colour. Although the way in which the black separation is made can radically affect the final result, the theory of subtractive reproduction relates to the three primary colours of yellow, magenta and cyan. Subtractive color mixing operates by “subtracting” out one or more colors of light.

In ideal subtractive colour behavior, each of the primary colours would subtract one third of the spectrum. The yellow ink would absorb the blue portion and reflect a mixture of red and green light appearing yellow to the eye, which cannot analyse it into its component parts; the magenta ink would absorb the green portion and reflect blue and red; with the cyan ink absorbing the red portion and reflecting blue and green.

The subtraction of red, green, and blue is achieved by using colorants that are their opposites.

- ♦ For red, this is a color made up of blue and green (i.e., minus red), called **cyan**.
- ♦ For green, this is a color made up of red and blue (i.e., minus green), called **magenta**.
- ♦ For blue, this is a color made up of green and red (i.e., minus blue),called **yellow**.

Colors are achieved by subtracting light away from the white paper (which reflects red, green, and blue). A combination of yellow (minus blue) and cyan (minus red) will, for example, result in green. Table below shows the possible combinations.

Green + Blue	= Cyan
Red + Blue	= Magenta
Red + Green	= Yellow
Red + Green + Blue	= White
No Light	= Black

Table: Subtractive color combinations.

A continuous blend of colors between the gamut limits is obtained by varying the quantity of any or all of the primary colorants deposited within the image. In color photography, this is achieved in a purely subtractive manner, by varying the density of the cyan, magenta, and yellow dye layers. Most color printing, however, relies upon a combination of a fixed density (ink film thickness) and a variable area coverage to adjust the quantity of ink deposited. The "halftone" structure that results from the combination of inked dot areas printed upon a white paper base is optically fused by the eye to produce a continuous-tone appearance.

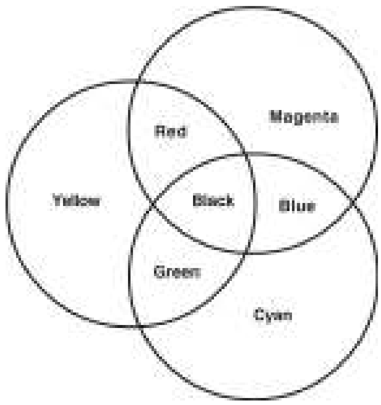


Figure 4-3. The principles of subtractive color reproduction in the digital imaging and printing industry. Yellow, magenta, and cyan colorants are superimposed upon a white substrate.

Cyan, Magenta and Yellow are the subtractive primary colors. They are called two-third colors because each represents two thirds of the spectrum. They can be produced by superimposing the light of two additive primary colours.

Process colour separations

To produce a set of four colour separations the original is scanned/input on an, electronic colour scanner using RGB (red, green, blue) light sources and output for printing purposes as CMYK (cyan, magenta, yellow, black) separations.

The figure below, illustrates the use of BGR colour lights/ separation filters to produce YMC separations or printing plates; K (black) is reproduced from a yellow / orange combination-type filter.

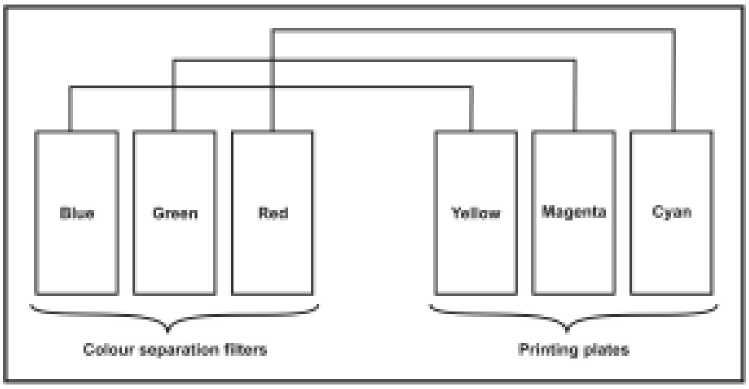


Figure: Colour separation lights/filters and their respective printing plates

The principle of colour separation is probably best considered from the traditional method, where the blue filter is dense in the areas of the image representing the parts of the original reflecting or transmitting blue, less dense where there is less blue light and transparent where there is none; the printing plate therefore produced from the blue filter is the yellow plate. On the same basis the green filter produces the magenta plate and the red filter the cyan plate.

Printed Color Reproduction

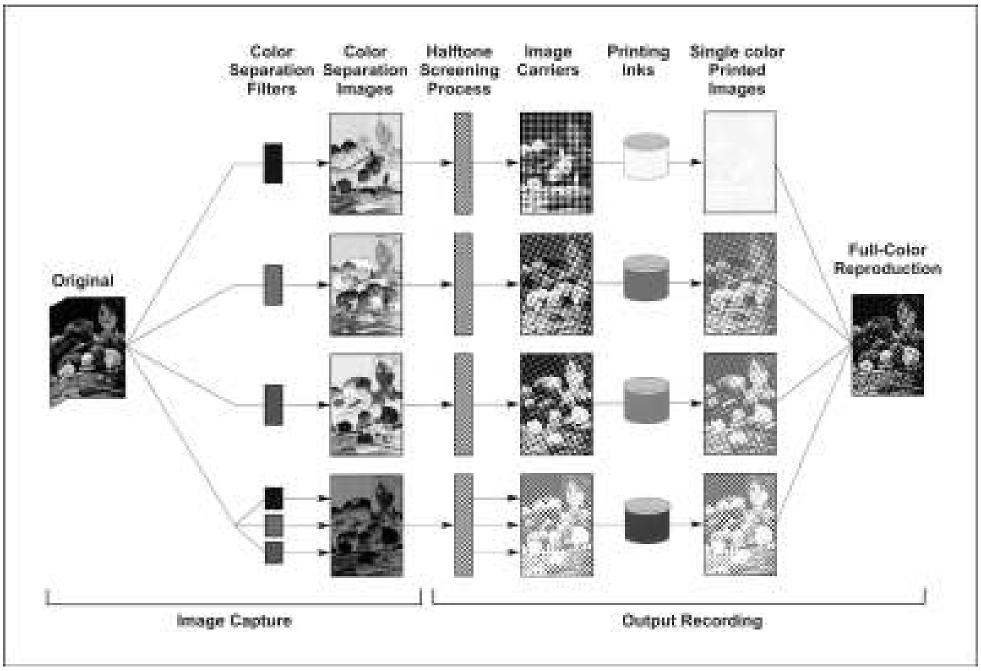


Figure: The principles of color reproduction in printing.

The key objective in the photomechanical color reproduction process is to produce cyan, magenta, and yellow images that are negative records of the amount of red, green, and blue in the original. This is achieved by initially photographing the original, in turn, through red, green, and blue filters. The subsequent image records or signals are adjusted as required prior to generating a halftone image that suits the chosen printing process. The images are then used to generate image carriers, which may be plates, cylinders, or stencils. Each plate is inked with its appropriate color which is sequentially transferred, in register, to a white substrate. The more direct electronic ("digital") printing systems eliminate films, or even plates, from the production process.

There are practical considerations that limit the thicknesses of cyan, magenta, and yellow inks that may be printed by most processes; consequently, a black printer is normally employed to compensate for the resulting loss of image contrast. The black printer is made by photographing the original sequentially through red, green, and blue filters, and then following procedures similar to the other colors. Below figure shows the complete process in schematic form. The exact nature of the printed image will depend upon the process used to form and transfer the image.

Concluding Analysis

The additive and subtractive color reproduction processes are both of interest to the printing industry: the additive because color monitors operate on this principle, and the subtractive because the printed product is produced by such means. Color fusion-the process by which discrete image elements are visually blended into a continuous color sensation is an essential aspect of these color imaging processes.

Too much is often made of the differences between additive and subtractive methods of color reproduction. In practice, if the ambient lighting is controlled, surface characteristics are neutralized, gamuts are equalized, and the viewing geometry is optimized, then an observer cannot tell whether an image is formed by RGB or CMYK processes.

Today's additive and subtractive color reproduction processes are based upon trichromatic principles. Trichromatic methods of color reproduction are, in theory, sufficient for optimum quality. In practice, however, the actual materials and processes in use do not produce the theoretical color gamut. This is the reason why a supplementary black printer is used in the color printing process and why extra chromatic colors are often desirable.

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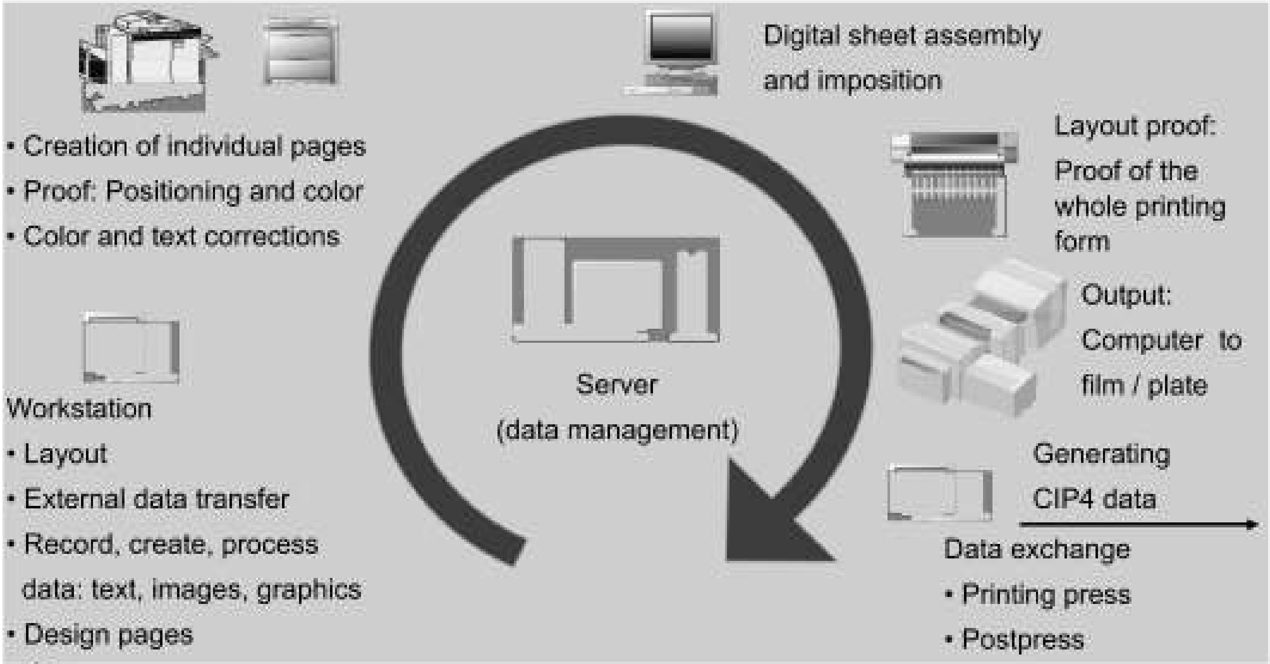
General prepress workflow



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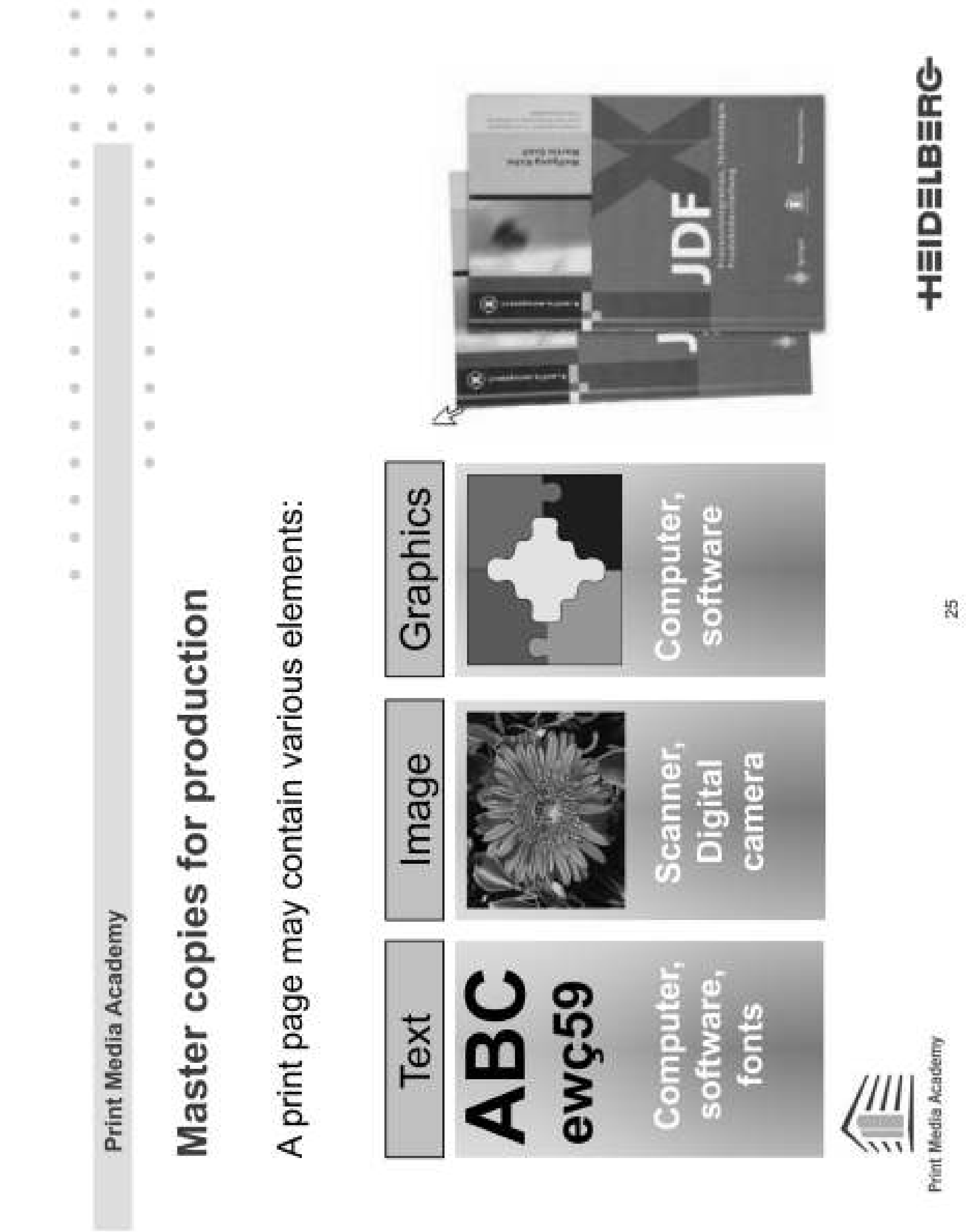
Print Media Academy
Master copies for production
A print page may contain various elements:
Text
ABC
ewç59
Computer, software, fonts
Image
Scanner, Digital camera
Graphics
Computer, software
JDF
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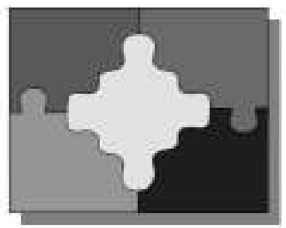
Master copies for production

Artwork masters: Lineart masters

- Only binary tone values can be printed in offset, i. e.:

  print or not print!
- Lineart masters consist only of such binary elements:

  smooth "solid" line or *no line*
- Single-color or multi-color lineart masters can be processed



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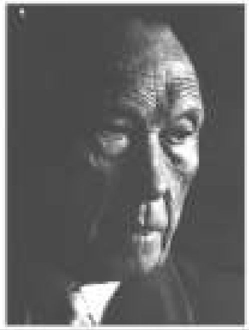
Master copies for production

Artwork masters: Continuous-tone images

– Images with a smooth progression in tone values:
  - monochrome
    = tone values only in gray scales
  - color
    = tone and color values

– Continuous-tone images must be converted technically, to obtain binary printing elements, i. e. continuous-tone images must be screened



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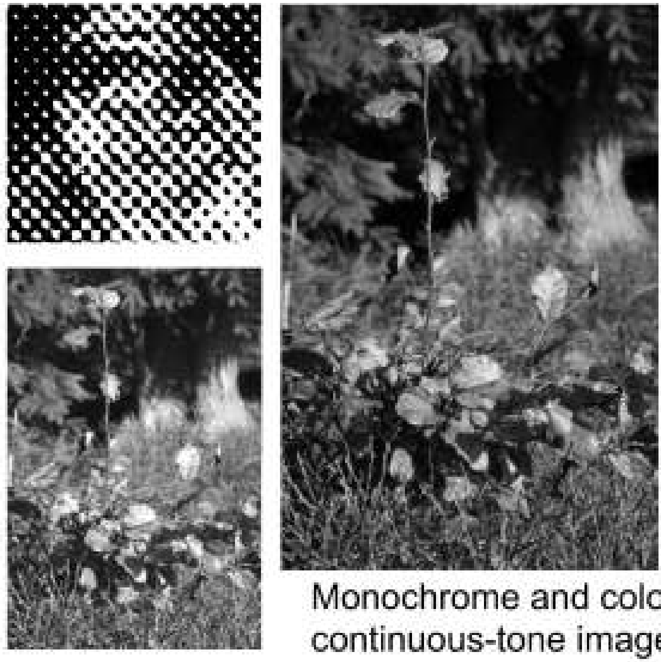
Master copies for production

Artwork masters: Continuous-tone images

- Screening
  - to break down an image into individual binary printing elements
- Color separation
  - Color separation of a colored original produces partial images for printing with the process colors C, M, Y and additionally K



Monochrome and color continuous-tone images

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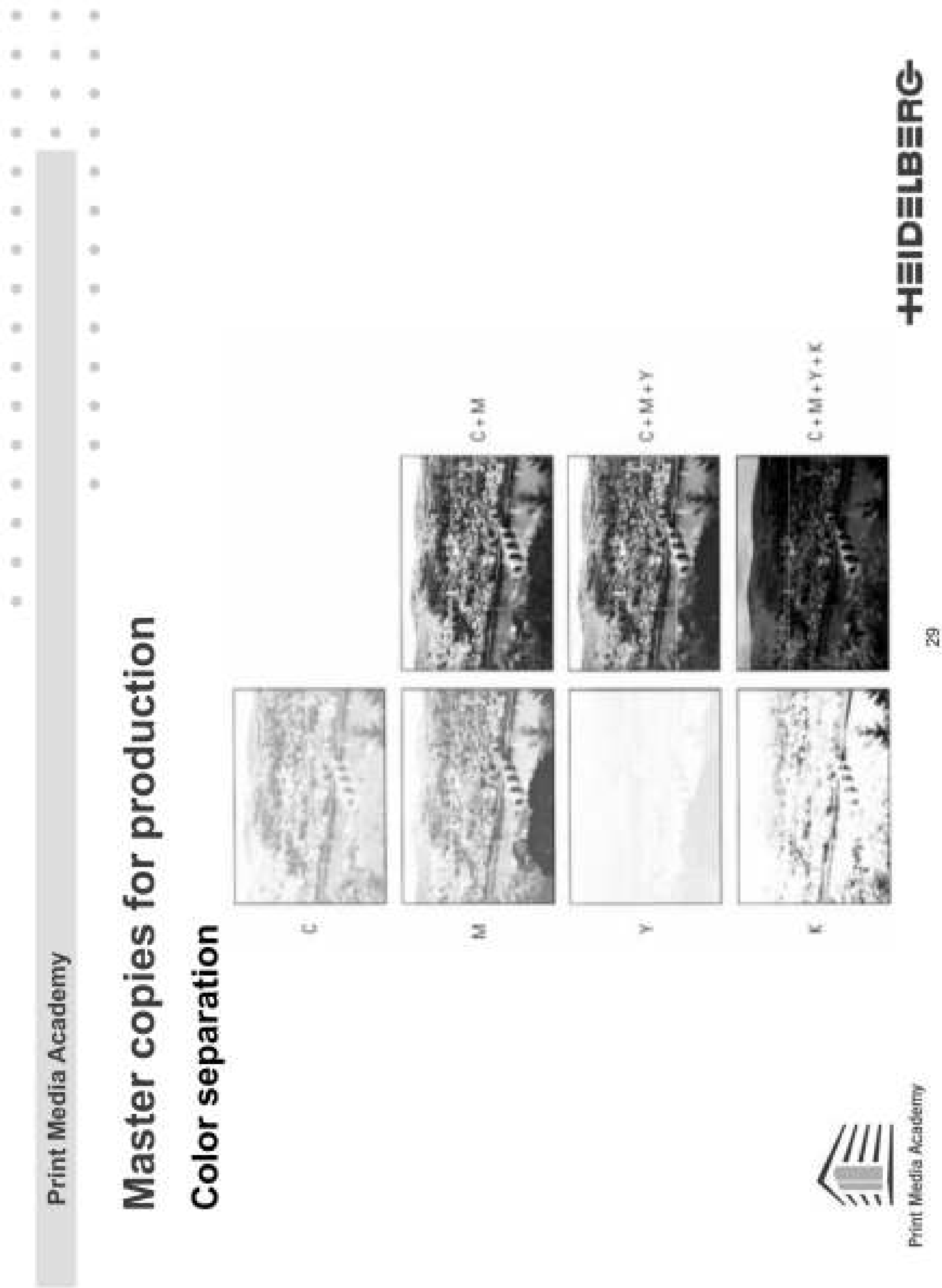
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Master copies for production
Color separation
C
M
Y
K
C+M
C+M+Y
C+M+Y+K
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Light and color

Our colorful world

Color is an everyday sensory experience that we take for granted

- Color
  - provides information
  - is decorative
  - affects us
  - signalizes
  - classifies
  - shouts and ...



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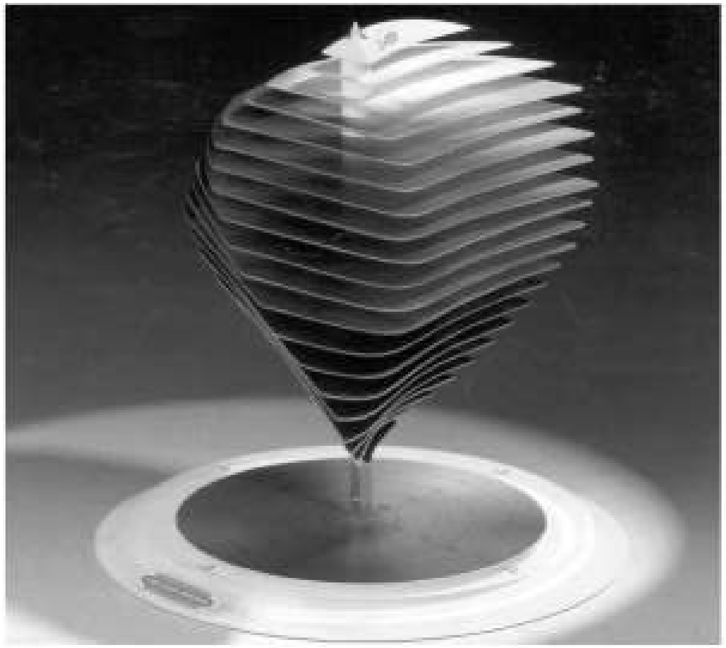
Light and color

Our colorful world

- Color is an optical effect, i. e. a sensation conveyed by the eye and brain
- Nature itself is colorless. It only gets its color through light
- ***Color is light***



Color in the system: CIELAB color solid

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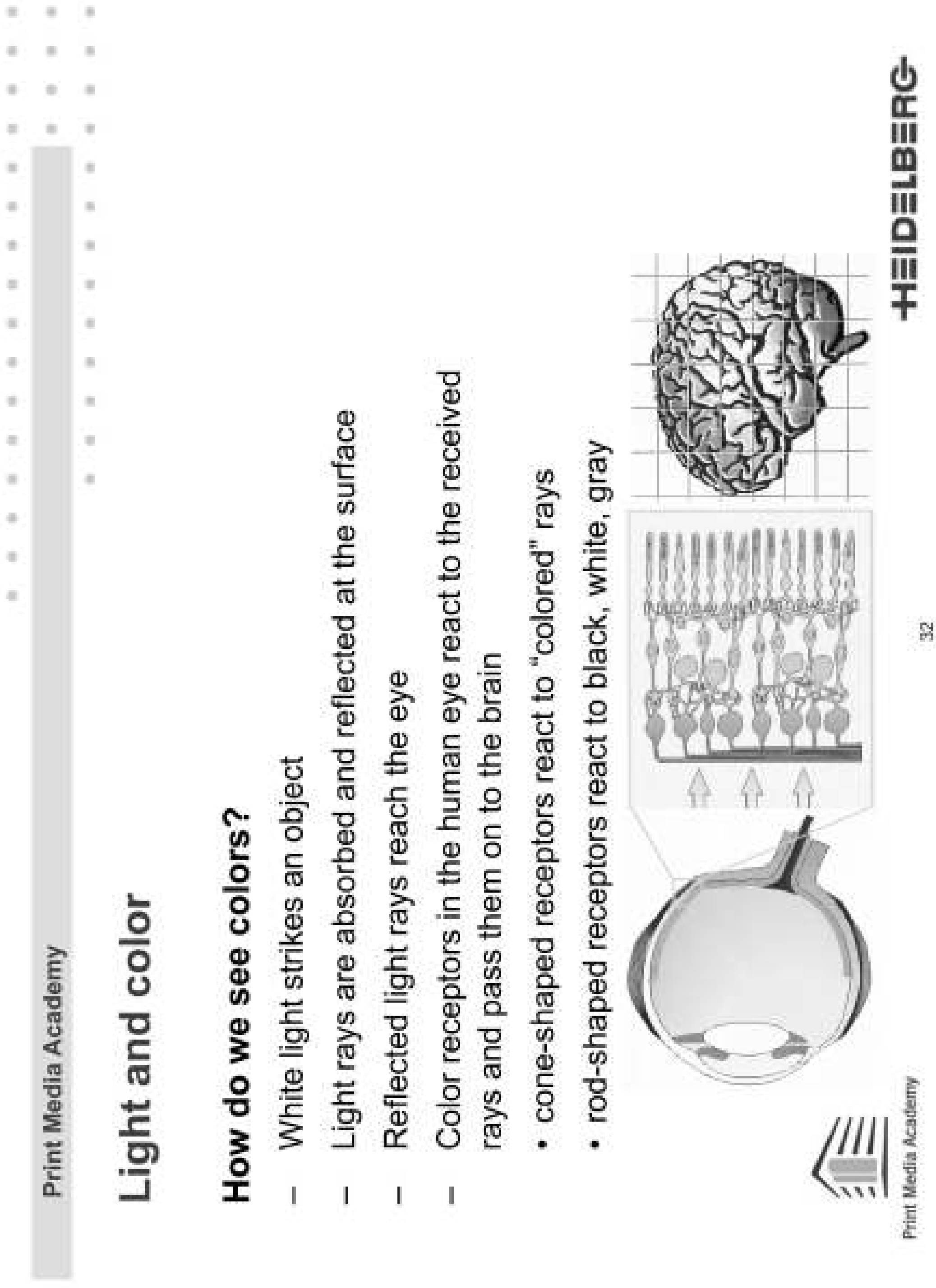
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Light and color
How do we see colors?
– White light strikes an object
– Light rays are absorbed and reflected at the surface
– Reflected light rays reach the eye
– Color receptors in the human eye react to the received rays and pass them on to the brain
• cone-shaped receptors react to "colored" rays
• rod-shaped receptors react to black, white, gray
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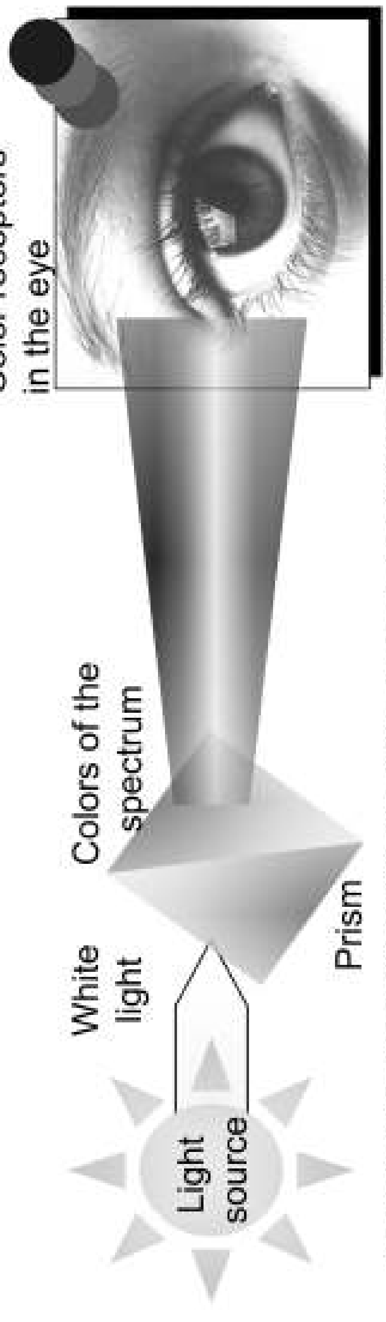
Light and color



- Model: A prism splits white light into the colors of the spectrum
- The visual perception of the beams takes place in the eye, the brain adds up all of the spectral energy to create a sensation: An image is formed from the information received – gray or colored!
- White: The total of all colors of light is received
- Black: No light = no color visible

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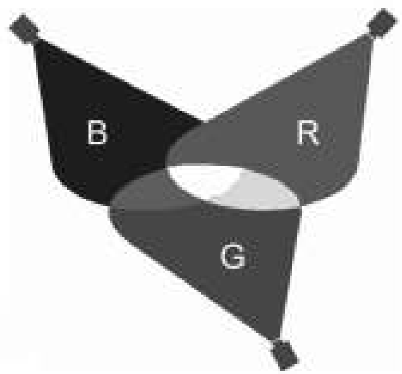
Light and color

Additive mixing

- Mixing colors of light
- Primary colors: red, green and blue
- Mixing these primary colors
  at full intensity produces white light.
  Increasing the addition of the colors of light
  leads to increasingly lighter mixed colors,
  if the intensity of the radiation is reduced,
  the lightness and color strength go down

Examples of technical equipment that "creates" colors additive mixing are televisions, monitors, projectors, video devices



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Light and color

Subtractive mixing

- Certain color components of the light rays from white light striking a body are absorbed by the body, while others are reflected

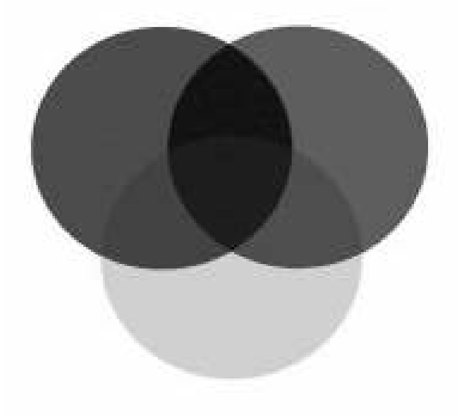
  = Components of the light are subtracted

- Mixing body colors:

  Primary colors: cyan, magenta and yellow

- The optimum mixture of these primary colors produces black.

  Reducing the components equally produces gray values from dark to light



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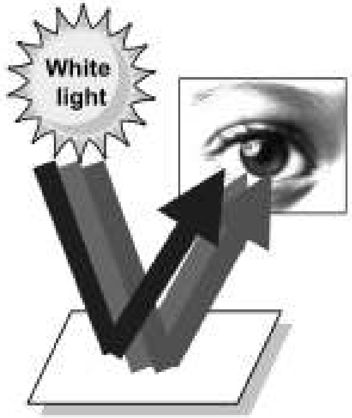
Light and color

Subtractive mixing in the printing process

- White paper reflects all of the light striking it
- The more ink is printed on the paper, the more light of certain radiation is absorbed
- The body's own "color" absorbs complementary radiation and reflects its own radiation, that is passed on by the eye to the brain:

  Color is a sensation



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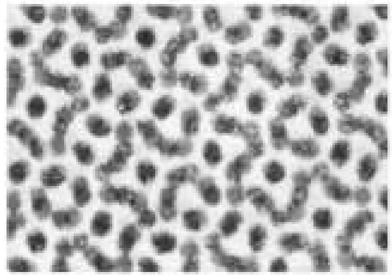
Light and color

Subtractive mixing in the printing process

- Image reproduction in four-color printing is achieved using the process colors cyan, yellow, magenta and black
- Tone and color values of multi-color images must be separated in the correct proportion into cyan, yellow, magenta and black components
- Screening: Each color separation must be converted into binary, printable elements
- Autotypical color mixing:

  To the observer there is both an additive as well as a subtractive response



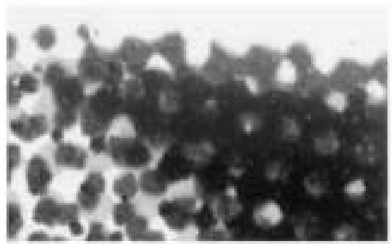


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IMAGE PROCESSING
UNIT – I - ORIGINALS & COLOR

PART –A ***1 Mark Questions***

1. What is an original?

Any copy whether it is a mechanical, artwork or other material from which reproductions are to be made is called as an original.

2. What are the types of originals?

1. Reflection originals 2. Transmission originals

3. What is Reflection original?

Any original copy which is to be reproduced that exists on an opaque substrate (such as photographic print) is called as Reflection Original.

4. Give some examples for Reflection originals?

Photographic color prints, paintings, wash drawings are termed reflection originals.

5. What is Transmission original?

Any original copy which is to be reproduced that exists on a transparent substrate (such as photographic transparency) is called as Transmission Original.

6. Give an example for transmission original.

Color Transparency is an example for Transmission original.

7. What is Line original?

Line originals have no gradation of tones that is, they possess no intermediate tones.

8. State some examples for line originals.

Paper paste-up from phototypesetters, typewriter or laser-printed line copy, dry transfer lettering; pen and ink effect drawings, or their digital equivalent produced electronically, Technical drawings, figure drawings, architectural plans, etc.

9. What are Monochrome line originals?

Line originals prepared for single color are called as monochrome line originals.

10. Give an example for monochrome tone original.

Black and white Photographs

11. What are color line originals?

Line illustrations may be produced for printing in two, three, four or more colours, with a separate colour split for each colour are called as color line originals.

12. Color Transparencies, color prints, color paintings are the examples for color tone originals.

13. What are continuous tone originals?

Continuous tone originals, consist of a variety of gradations between highlights (lightest areas), mid tones (neutral/mid-way areas) and solids (darkest areas).

Tone originals may be,

1. Monochrome Tone Originals (eg. Black and White Photographs)
2. Color Tone Originals (eg. Color Transparencies, Color Prints or Color artwork).

14. What are Colour originals?

Pictures representing line and tone in colour are called color originals.

15. What are halftone originals?

Originals in which detail and tone values are represented by a series of evenly spaced dots of varying size and shape, the dot areas varying in direct proportion to the intensity of the tones they represent are called as halftone originals.

16. What are the types of halftone originals?

Black and White halftone originals

Color halftone originals

Digital halftones.

17. What are Merchandise samples?

In those cases where a very accurate color match is required, an actual sample of the product is sometimes supplied for use as an original. Examples are paint chips, fabric swatches, linoleum squares, or upholstery samples.

18. What is Light?

Light is radiant energy that is visible to the average human eye. Light travels in wave motion, with the color of light varying according to the length of the wave.

19. State the unit of light.

The intensity (or luminosity) of a light source is measured in candles. The intensity of light reflected from a surface (or luminance) is measured in candles per square meter, or foot candles or foot lamberts.

20. What is Color?

The term color refers to the quality of light possessing certain dominant wavelengths. Color is a complex visual sensation that is influenced by the physical properties of the illuminant and sample, but is determined largely by the physiological characteristics of the individual observer.

21. What are the properties of colour?

The colorimetric properties of color are those that describe its three dimensions:

- Hue
- Saturation, and
- Lightness

22. State the three (different) categories of colors.

Three categories of colors are : primary colors , secondary colors , and tertiary colors.

23. Define Primary colors

Primary colors are those that are not formed by the mixing of any other colors and can be said to be pure colors.

Eg: Blue, Green, and Red colors

24. Define Secondary colors.

Secondary colors are those formed by the mixing of two or more primary colors.

Eg: Yellow, magenta, and cyan colors.

25.Define Tertiary colors.

Tertiary colors are those produced by the mixing of two or more secondary colors.

26. What are light or additive primaries?

Blue, Green, and Red are called as light primary colors.

27. What are printing or subtractive primaries.

Yellow , magenta, and cyan are called as printing primary colors.

28. Why do an apple appear red?

An apple appears red as it reflects the red light and absorbs most of the violet, blue, green and yellow lights.

29. Define Visible light?

Visible light is technically detined as electromagnetic radiation having a wavelength between approximately 380 nanometers and 780 nanometers.

30. What is the electromagnetic spectrum?

The electromagnetic spectrum includes a broad range of different types of generated energy, ranging from radio waves and electrical oscillations, through microwaves, infrared, the visible spectrum, ultra violet radiation, gamma rays, and high-energy cosmic rays.

31. What are process colors?

Yellow, Magenta, cyan and black colors that are used for making printed color reproductions are known as process colors.

32. What are neutral colors?

Neutral colors do not possess the properties of hue or saturation but are described according to their lightness-white, black and gray are neutral colors.

33. What are one-third colors?

Red, green, and blue are called one-third colors because each represent one third of the visible spectrum.

34. What are two-third colors?

Yellow, Magenta and cyan are the two-third colors because each represents two thirds of the visible spectrum. They can be produced by superimposing the light of two additive primary colors.

35. A black body reflects none of the incident radiation. Why?

A black body absorbs all the incident radiation that falls on the surface. Hence it will not reflect any incident radiation.

- -

GLOSSARY

Achromatic: Without color or hue (black and white).

Art/Artwork: All illustration material used in preparing a job for printing. May also referred to drawings and charts specifically.

Black Printer: In color reproduction, the black plate is generated to increase contrast of dark tones and make them appear neutral.

CMY (Cyan, Magenta, Yellow): Subtractive primary colors, each of which is a combination of two additive primary colors (RGB).

CMYK (Cyan, Magenta, Yellow, and Black): The subtractive process colors used in color printing. Black (K-key color) is added to enhance color and contrast.

Color Conversion: Producing a color transparency from a color reflection original so that a flexible copy of the original can be color-separated on a rotary-drum scanner.

Color Filter: A sheet of dyed glass, gelatin or plastic, or dyed gelatin cemented between glass plates, used in photography to absorb certain colors and transmit others. The filters used for color separation are red, green, and blue.

Colorimeter: An instrument that measures and compares the hue, purity, and brightness of colors in a manner that simulates how people perceive color.

Continuous tone: An image that contains gradient tones from black to white. It has infinite tone gradations between the lightest highlights and the deepest shadows

Contone: Abbreviation for continuous tone.

Copy: Any furnished material (files, typewritten manuscript, pictures, artwork, etc.,) to be used in the production of printing.

DCS (Desktop Color Separation): In digital pre-press, a data file defined to assist in printing process color separations using desktop color systems. Using DCS, five files are created: cyan, magenta, yellow, and black image data, and a composite color preview of the color image.

Duotone: In photo-mechanics, a term for a two-color half tone reproduction from a one-color photograph.

Generation: Each succeeding stage in reproduction from the original. A copy of an original would be the second generation.

Hard copy: the permanent visual record of the output of a computer or printer on a substrate. “Soft” copy refers to images displayed on screens.

Hard proof: A proof on paper or other substrate as distinguished from a soft proof that is an image on the screen.

HSV: Acronym for Hue, Saturation, and Value (or brilliance or luminance) – a color space used in some graphic programs.

Hue: In color the main attribute of a color that distinguishes it from other colors.

Hue Error: A measure of the hue deviation from a theoretically perfect subtractive process (primary) color.

Line Images: Solid areas with no shading or tones, including type, drawings, and diagrams.

Mechanical: A term for a camera-ready paste-up of artwork. It includes type, photos, line art etc., all on one piece of artboard. It is photographed in a graphic arts camera and the resultant film is stripped into flats for platemaking.

Prepress: All printing operations prior to presswork, including page design and layout, typesetting, graphic arts photography, image assembly, and platemaking.

Process colors: In printing, the subtractive primaries: yellow, magenta, and cyan, plus black in four-color process printing. Referred to as CMYK.

Reflection copy: In photography, illustrative copy that is viewed and must be photographed by light reflected from its surface. Examples are photographs, drawings, etc.,

Reflectance: The ratio between the amount of light reflected from a given tone area and the amount of light reflected from a white area.

RGB (Red, Green, and Blue): The primary additive colors used in display devices and scanners. Commonly used to refer to the color space, mixing system, or monitor in color computer graphics.

Saturation: The degree to which a chromatic color differs from a gray of the same brightness.

Spectrophotometer: Instrument for measuring color for CIE color spaces. It is more accurate than most color colorimeters.

Spectrum: The complete range of colors in the rainbow, from short wavelength (blue) to long wavelength (red).

Subtractive primaries: Yellow, magenta, and cyan, the hues used for process color printing inks.

Transparency: Color positive film. In digital imaging, a computer capability to make graphics and images transparent so that underlying graphics and images show through.

Transparent copy: In photography, illustrative copy such as a color transparency or positive film through which light must pass in order for it to be seen or reproduced.

Ultraviolet Radiation: The range of electromagnetic radiation that lies outside the visible spectrum. In the graphic arts, UV rays are used to induce photochemical reactions.

Vignette: An illustration in which the background or image fades gradually away until it disappears by blending into areas of the unprinted paper.

Wavelength: The distance between corresponding points on two successive waves of light or sound.

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1. State the various types and classifications of originals.

Types of Originals

There are two types of originals:

1. Reflection Originals and
2. Transmission Originals

CLASSIFICATION OF ORIGINALS

Originals can be further classified as follows:

1. Line originals.
2. Tone or Continuous Tone originals.
3. Color originals.
4. Halftone originals.
5. Merchandise Samples.

2. Define halftone originals. State the types of halftone originals along with examples.

Halftone Originals

Originals in which detail and tone values are represented by a series of evenly spaced dots of varying size and shape, the dot areas varying in direct proportion to the intensity of the tones they represent are called as halftone originals.

i. Black-and-White Halftone Originals

Examples of halftone originals are printed pictures in newspapers or magazines.

ii. Color Halftone Originals

Color photographs printed in magazines, newspapers, or books.

iii. Digital Halftones

When using scanned images or images from a digital camera, you can produce digital halftones direct from the software to the printer.

3. How will you handle originals?

HANDLING OF ORIGINALS

- Any dust, finger marks, scratches, or other defects on an original have to be avoided during the reproduction, as they will be magnified during printing.
- Care should be taken in handling all originals, preferably keeping them in mounts or sleeves except when they are being scanned.
- A quick wipe over the surface of an original before scanning can save a great deal of time pixel cloning later in an image-editing program.
- On some scanners , transparencies are mounted in oil to improve the contact with the scanner drum and reduce the likelihood of scratches and Newton's rings appearing on the scanned image. If scratches or other marks appear on an image they can be removed in an image-editing application

Other requirements of good originals include good tonal gradation and good tonal separation between areas of detail (bearing in mind that this tonal separation will be compressed when the image is scanned).

4. Define light.

Light is radiant energy that is visible to the average human eye. Light travels in wave motion, with the color of light varying according to the length of the wave. Light can either be a wave as was first proposed by Christian Huygens, or as a series of discrete particles as was first proposed by Sir Isaac Newton. Eventually it was decided that light could be both a wave and a series of particles.

The intensity (or luminosity) of a light source is measured in candles.

5. Define color.

Colour is an optical effect, i.e., a sensational conveyedby the eye and brain. Objects and nature itself are colorless. They get their color through light. Color is light.

The term color refers to the quality of light possessing certain dominant wavelengths.

Color is a complex visual sensation that is influenced by the physical properties of the illuminant and sample, but it is determined largerly by the physiological characteristics of the individual observer. Insights into the process of color perception may be gained through examinations of these distinct elements (illuminant, sample, human observer) and the manner in which they interact.

6. How do humans perceive colors?

The human perception of colour

The sensation of colour is the effect of light upon the eye interpreted by the brain. White light is composed of a mixture of all colours of the rainbow or spectrum, and most objects are visible by the light reflected or transmitted from them, depending upon whether the object is opaque or transparent. The colors of the visible spectrum include (in order of increasing wavelength) violet, indigo, blue, green, yellow, orange and red.

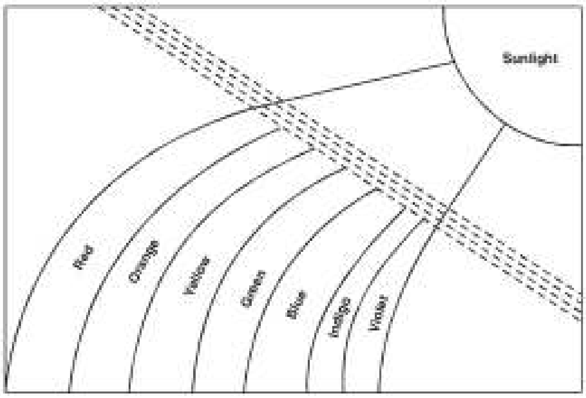

Figure: White light is composed of all the colours of the rainbow / visible spectrum

White light appears to have no color because all the wavelengths are present in equal amounts, effectively “cancelling” each other out. Objects appear colored because they reflect or transmit some parts of the spectrum and absorb the others. For example, a red object appears red as it reflects the red light and absorbs most of the violet, blue, green and yellow lights. White objects reflect or transmit almost all parts of the spectrum, while tones of gray absorb equal proportions of all its constituents and black absorbs almost the whole of it.

7. Define Hue.

Hue

- **Hue** is the name given to a specific colour, to differentiate it from any other.The hues blue, green and red; yellow, magenta and cyan form the familiar colour wheel- see Figure Color Wheel.

The **hue** identifies whether a color is red, blue, green, yellow, or some combination term as greenish yellow or bluish red. Such other terms as magenta or crimson are often used as hue names. Hue may have an infinite number of steps, or variations, within a color circle. A circle displays all the hues that exist; indeed, it can be said that any reproduction process is capable of matching any given hue.

8. Describe saturation.

Saturation

- **Saturation**, similar to **chroma**, indicates the purity of a colour. It refers to the strength of a colour, - i.e. - how far it is from neutral gray.

A gray-green, for example, has low saturation, whereas an emerald green has higher saturation. A color gets purer or more saturated as it gets less gray. In practice this means that there are fewer contaminants of the opposite hue present in a given color. To illustrate this concept, imagine mixing some magenta pigment with a green pigment (the opposite hue). The green will become less and less saturated until eventually a neutral gray will be produced. A gray scale has zero saturation. The figure below shows the magenta-green saturation continum. Magenta becomes desaturated by the addition of green in the same way green becomes desaturated by the addition of magenta.

As a color becomes less saturated, it is said to be dirtier or duller, and as it becomes more saturated, it is described as cleaner or brighter.

9. Explain brightness.

Brightness / Lightness

- **Brightness**, similar to **lightness, luminance** or **value**, describes how light or dark a colour is, indicating whether a colour is closer to white or to black: brightness does not affect the hue or saturation of a colour. Grey is a neutral 'colour' between white and black - to lighten a colour the brightness or lightness element is changed.

In fact, the terms lightness and darkness are synonymous. Lightness or darkness of a solid color may be changed by mixing either white or black ink with the color. In process-color printing this is achieved by printing a color at various halftone percentages from 0 to 100 (mixing with white), then overprinting the 100% solids with increasing percentages of black (mixing with black).

10. Define duotones.

It is a term for a two color halftone reproduction made from a simple color original. Duotone requires two halftone films with proper screen angles. One color usually printed in dark color and the other in lighter color.

PART – C ***12 Marks Questions***

1. Define originals. Explain the various kinds of originals with examples
2. Describe (i) Light (ii) Colour with necessary sketches
3. Explain the principles of colour, Describe the properties of colour.
4. Explain the colorimetric properties of color.
5. Write notes on (i) Hue (ii) Saturation (iii) Brightness
6. Explain (i) The electromagnetic spectrum (ii) The visible spectrum.
7. Explain the additive color theory with sketches.
8. Explain the subtractive color theory with necessary sketches.