

## **I. The objectives of color reproduction**

**A. *The objectives of a color reproduction are varied and can be elusive***

**B. *Variables***

1. Type of original
  - a) *The original object*
  - b) *A photograph of the original object*
    - (1) transparency
    - (2) digital photograph
  - c) *A photograph of a photograph of the original object*
    - (1) color print
2. Reproduction process
  - a) *color separation process*
  - b) *ink characteristics*
  - c) *paper characteristics*
  - d) *printing process characteristics*
3. Requirements of print buyer
4. Expectations of the end user or consumer

## **II. Exact color reproduction—match the original**

**A. *Reproduction of fine art***

1. paintings are often reproduced in catalogs, postcards, calendars or books.
2. reproduction should convey the color and tonal properties of the original as closely as possible.

**B. Reproduction of artwork prepared by graphic designers**

1. Sole purpose of such art is reproduction
2. Custom jobs
  - a) *Designer may specify ink and paper*
  - b) *Designer must know interaction between ink and substrate chosen.*
3. Magazine or other publications
  - a) *designer cannot specify inks or paper*
  - b) *designer must be aware of the color standards being employed by the publication and choose colors within the gamuts of that standard.*
4. If the artwork is impossible to reproduce under the specified conditions, it has failed as commercial art.
5. If the designer cannot find out the standards being employed, at least he or she should find out if coated or uncoated paper will be used, then choose colors from SWOP standard.

**C. Product colors**

1. Very important, especially in clothing, paint chips, fabrics, car colors, and other products illustrated in catalogs.
  - a) *Consumers often base purchase decisions on the colors they see illustrated in catalogs.*
2. Products that can be brought into the color separation area:
  - a) *paint chips, fabrics, etc.*
  - b) *fairly simple to compare proof to original*
3. Products that cannot be brought into the color separation area:
  - a) *machines, cars, etc.*
  - b) *very difficult to match colors because the original scanned is a photograph of the object*

- (1) the photograph itself is an inaccurate representation of the product.
4. Consider the gamut of the ink/paper combination
    - a) *If the color can be reproduced by standard (SWOP) colors, everything is OK.*
    - b) *If the color is outside the gamut, a fifth (or more) color may be necessary to achieve a match.*

### **III. Relative color reproduction—match the meaning**

#### **A. Photographs are usually used as originals for reproduction**

#### **B. Photographs are not accurate reproductions of reality**

1. Color casts
  - a) *Impact of lighting (already discussed)*
    - (1) Indoor photographs can be captured with controlled lighting
    - (2) lighting for outside photographs can never be controlled.
  - b) *Impact of type of color film (show examples on pg. 158–160 of Color and Its Reproduction)*
    - (1) brand and type of color film
      - (a) *the same brand and type of film should be used for a series of photographs to be viewed or reproduced together.*
    - (2) exposure of the film
    - (3) optical system of the camera
    - (4) processing of the film
    - (5) some films are not intended to be used as originals for print reproduction
      - (a) *designed to be illuminated by projector in darkened room.*

(b) *gamma and contrast of slide film is too great for reproduction.*

2. Gray balance

a) *Neutral blacks, whites, and grays are very difficult for any color film to reproduce (must be exact right balance of red+green+blue).*

b) *Any color cast shows up predominantly in the grays. (Show pictures on page 169 of Color and Its Reproduction)*

3. Impact of the human visual system

a) *What the camera records is not the same as what the human sees.*

(1) For example, if a picture is taken in the twilight, the human's eyes will have adjusted to the darkness and become more sensitive to darker, more muted, colors. The film does not. If a photograph were taken in this scene, the photograph would look darker than what the human sees.

(2) Keep in mind effects of simultaneous contrast and surround effects.

4. Distortion inherent in color photographs

a) *loss of resolution*

b) *grain*

(1) slower film generally results in less grain

c) *poor sharpness*

d) *tonal distortions caused by the emulsion*

**C. Area of emphasis in a photograph**

1. A photograph may be of a couple relaxing on the beach in front of a hotel surrounded with native foliage (Margulis pg. 7)

2. In a relative color reproduction of this scene, one could emphasize:

a) *color of the water*

b) *features and color of the hotel*

- c) *color of the person's tan*
- d) *color of the person's swimsuit*
- e) *color of the foliage*
- f) *color of the sky*

**D. *The quality of a printed reproduction of a photograph should be based on how the consumer reacts to it.***

1. evaluate the reproduction on its own merits, not compared to an intermediate reproduction (the photograph)
2. the photograph submitted is merely a starting point, not an end in its own right.

**E. *Sometimes a photograph contains the exact distortions the designer wants***

1. it becomes an "exact reproduction" rather than a "relative reproduction."

#### **IV. Optimum color reproduction**

**A. *Optimum color is the best reproduction under the circumstances***

1. The best reproduction is the one that most people would choose from a sampling of reproductions made from the same original.
2. The circumstances include
  - a) *ink and substrate*
    - (1) gamut
    - (2) density
      - (a) *Compared to an original photograph, tonal ranges are compressed when the photograph is reproduced using CMYK inks.*

Color	Uncoated Paper	Coated Paper
Yellow	0.75	0.95
Magenta	0.95	1.20
Cyan	0.95	1.10
Four-Color	1.50	2.00

(b) *Whereas an original may have a shadow density exceeding 3.00, the darkest CMYK can produce is approximately 2.00.*

b) *choice of lpi*

Process/Substrate	LPI
Screen-Textiles	50
Letterpress—newsprint	65–85
Screen printing—smooth surfaces	85–110
Flexography	85–110
Letterpress—machine finished	100
Lithography—machine finished	120–133
Letterpress—coated	133–150
Gravure—all substrates	150–200
Lithography—coated	150–250

- (1) Generally, the higher the lpi the better.
- (2) Using too high lpi results in plugging of shadows.
- (3) lithography has the highest resolving-power of any process, and can produce the smallest dots.
- (4) Lower lpi screens are OK for images to be viewed from a distance.

c) *printing process*

d) *color separation and correction process*

e) *characteristics of the original*

**B. Quality is generally a factor of the cost of the materials and process**

1. More expensive materials and procedures generally produce higher-quality results
2. In publications that use a specified set of materials, the choice of more expensive products is not available.

a) *The limits of quality are fixed*

- b) *separations must be produced to achieve the best result under these fixed conditions.*

**C. *Buyers of printing and designers should realize that there are finite quality limits inherent by the ink-substrate-process combination.***

## **V. Tone reproduction**

### **A. *Reality of tone compression***

1. The density range of an original scene is greater than films can capture.
2. The density range of a photograph is greater than printed reproductions can produce.
3. Result is far fewer tones in a printed reproduction than in the original scene.
  - a) *it is impossible to produce a 45° input/output density curve.*
  - b) *more likely is the flatter curve shown in the graph (use overhead)*
4. Original transparencies often contain density ranges exceeding 3.0.
  - a) *Press sheets, even on coated paper, rarely exceed 2.0*
  - b) *Result is a density loss of 1.0.*

### **B. *Gamma***

1. The ratio of the density range of an original compared to a reproduction.
  - a) *A gamma of 1.0 means that the tones in a reproduction show the same separation as those in an original.*
  - b) *A 1.0 gamma curve is a 45° angle input/output curve*
    - (1) cannot be accomplished with printing processes
  - c) *A gamma less than 1.0 has an angle greater than 45° and increases contrast*

- d) *A gamma greater than 1.0 has an angle less than 45° and decreases contrast.*
2. Density of original = (gamma value) x density of reproduction
    - a)  $1.80 = (\text{gamma}) \times 1.20$
    - b)  $1.50 = \text{gamma}$
  3. The higher the gamma, the flatter the curve (less than 45°)
  4. A gamma of 1.80 is common
    - a)  $2.00 = 1.80$  (*repro density*)
    - b)  $1.11 = \text{repro density}$

### **C. Coping with tone compression**

1. It is impossible to reproduce most photographs with a gamma of 1.0.
2. Whenever the density range of an original exceeds the achievable range of a given ink-paper-process combination, some of the tonal range of an original *must be lost*.
  - a) *result is certain parts of the image must be emphasized at the expense of others.*
  - b) *reproductions should be made with a gamma of 1.0 or lower in the area of interest.*
    - (1) *emphasize highlights in high-key originals*
    - (2) *emphasize middletones in medium-key photograph*
    - (3) *result is tone curves rather than straight-lines (Show overhead of high-key and normal curves)*
      - (a) *high-key*
        - (i) darkens highlights (less than 1.0 gamma curve in highlights)
        - (ii) provides more contrast (straight-line/gamma 1.0 or less curve) in the highlights

(iii) loses contrast in the shadows

(b) *normal*

(i) emphasizes midtones

(ii) provides more contrast (straight-line/gamma 1.0 curve) in the midtones

(iii) loses highlight detail

(iv) loses shadow detail

3. Sales personnel must ascertain from clients the main interest area in each photograph so that area can be emphasized.

## VI. Color accuracy

**A. Refers to how closely a printed color agrees with that desired by the customer.**

1. Color balance

a) *how well the colors match the original scene or object*

b) *depends on gray balance of ink mixtures and color balance of originals*

2. Preferred color

a) *how closely a color matches the distortion desired by the customer.*

**B. Color balance**

1. Gray balance

a) *Refers to the combination of process-color inks to produce a neutral gray.*

b) *depends upon the colorimetric properties of the printing inks and substrate*

(1) all inks are somewhat deficient and do not produce an acceptable gray when overprinted 50% each.

c) *Correct percent of each process-color ink is found by printing a test gray balance chart (show Test Images book)*

*and find the percentages of CMY that produce a neutral gray.*

- (1) These numbers are then used to set the Printing Inks Setup dialog box in PhotoShop.
2. Color balance of originals
  - a) *Defects due to improper film-lighting combination.*
  - b) *Show examples on page 169 of Color and Its Reproduction.*
  - c) *PhotoShop can be used to correct the color balance of incorrectly exposed originals.*
3. If neutrals are properly reproduced, most other colors will also be satisfactorily reproduced.

### **C. Preferred color**

1. More difficult to obtain than color balance.
2. Depends on how the client wants a photograph intentionally distorted.
  - a) *darken skin colors to give tan*
  - b) *make water and sky bluer*
  - c) *make foliage on postcards greener*
3. Requires selective adjustment of each channel in PhotoShop.
  - a) *May require selecting only certain colors to edit*
  - b) *Make sky bluer by adding magenta (concept of the unwanted color)*

## **VII. Image quality factors**

### **A. Resolution**

1. dependent on chosen screen ruling as well as scanning resolution
  - a) *Generally, higher lpi's result in better resolution*

- b) *Proper scanning resolution (2 x lpi) results in best resolution.*
- 2. Resolution is also dependent upon:
  - a) *the grain inherent in the original photographic emulsion*
  - b) *photographic stages subsequent to imagesetting*
  - c) *resolving power of the plate*
  - d) *ink/paper/process interface*

### **B. Sharpness**

- 1. Refers to contrast at the edges of differing tonal values.
- 2. Sharpness can be increased using the Unsharp Mask in PhotoShop.
  - a) *Most CCD-scanned images and all PhotoCD images need to be somewhat sharpened.*
- 3. Guidelines for sharpness
  - a) *Natural subjects, such as landscapes or portraits, should have less sharpness (be softer)*
  - b) *Portraits are usually best with less sharpness.*
  - c) *Machines, products, jewelry should be more sharp.*

### **C. Graininess**

- 1. Refers to non-uniform distribution of silver grains in photographs.
- 2. Grain should be as low as possible for best reproduction.
- 3. Inherent in every photographic stage.
  - a) *You can't remove graininess from an original.*
  - b) *number of photographic stages should be minimized.*
- 4. Elliptical-dot screens help minimize graininess

**D. Moiré**

1. Most pronounced in browns, greens, and skin tones.
2. Some techniques to minimize moiré if it results in an unacceptable reproduction:
  - a) *switch angles of Y and K plates (if skeleton black is used)*
  - b) *use a finer screen for yellow than for other colors*
  - c) *switch magenta and black angles to reduce moiré in skin tones.*

**E. Surface Gloss**

1. Paper gloss for various reproductions depends on the nature of the original and the end-use of the product.
  - a) *Water-color or other painted originals look best on uncoated paper of a texture that simulates canvas*
  - b) *Photographic originals are best reproduced on glossy paper.*
  - c) *Smooth papers usually result in better reproduction.*
  - d) *Books that contain a combination of text and photographs should be printed on matte-finished paper to reduce glare.*

Color	Uncoated Paper	Coated Paper
Yellow	0.75	0.95
Magenta	0.95	1.20
Cyan	0.95	1.10
Four-Color	1.50	2.00

*Maximum tonal density of process ink  
on coated and uncoated papers*

Process/Substrate	LPI
Screen-Textiles	50
Letterpress—newsprint	65–85
Screen printing—smooth surfaces	85–110
Flexography	85–110
Letterpress—machine finished	100
Lithography—machine finished	120–133
Letterpress—coated	133–150
Gravure—all substrates	150–200
Lithography—coated	150–250

*LPI's for various process/substrate combinations*