

A Few Significant Principles of Color Harmony That Are Unique in Textile Design

By FABER BIRREN

In two previous articles* it has been pointed out that many factors enter into the effective use of color in textiles, and that the real attainment of beauty is not a matter of mere optional choice or adherence to some one principle or system of color harmony. In fact, beautiful color schemes can be worked out with almost mechanical regularity, basing the effects strictly on certain peculiarities of color evident in vision.

Development of Color Schemes

To demonstrate how "perfect" color schemes can be planned through simple and purely rational deductions, let the following points be orderly considered.

1. Color has dimension. Blues, violets and greens retire, while reds, oranges and yellows tend to advance. Thus cool hues are excellent for backgrounds when the desire is to display some pattern—and the pattern can well be designed with warm hues.

2. In the diffusion of colors it is found that adjacents show off to best advantage without becoming dull or somber in tone. Opposites diffused together become muddy. For further emphasis in any color scheme, adjacent colors can be diffused into backgrounds or patterns for a good substantial color purity and power.

3. Opposite color schemes are most striking. Yet such vivid effects can only be attained when a sufficient isolation exists so that the eye can readily distinguish and separate each color area. Thus a background can well be of opposite hue to a pattern, if strong color sensations are wanted.

4. After-image "fringes" can be greatly overcome through the use of outlines. If one color tends to modify another because of the after-image, much confusion can be eliminated by isolating them with an outline in some neutral tone, such as white, gray or black.

The above four points cover many factors of vision that qualify the efforts of the textile designer. They are things to be known and estimated in all color applications. In fact, many beautiful and "esthetic" harmonies can be attained by capitalizing on them—even though the capitalization is a mental rather than an emotional process.

For example, let it be assumed that the textile designer wishes to build a color scheme that is based on the

above visual factors. First of all, a cool color could be selected as a background because of the fact that it would retire to advantage. Blue might be a good first choice.

Secondly, to provide a good contrast to this blue, its opposite (yellow) might be chosen as the basis for a pattern. These two hues would have contrast. One would retire, the other would advance.

Thirdly, to introduce more diversity into the background, adjacent colors could be woven into the blue. Violet and blue-green could be diffused with the blue. Strong color power would follow. Then if this more elaborate background made the yellow pattern appear rather plain, the same strategy could again be employed. That is, the adjacents of yellow, which are orange and yellow-green, could be diffused into the pattern.

Fourthly, a fairly complicated but consistent effect would be created. If now, however, the cool adjacent colors of the background should clash with the warm colors of the pattern and form an undesirable color "fringe", due to the after-image, the fault could be corrected by isolating the pattern from the background through the introduction of a black, gray or white outline. Here would be a "perfect" color scheme developed with careful respect to the several factors of vision that enter into the use of color in textiles.

The above example is, of course, merely theoretic. It is given to show how the development of color schemes does not have to be haphazard. The textile designer has several devices at his command, and while he is not invariably seeking complicated and expensive color schemes such as the one described above, he can take advantage of all the visual peculiarities of color, basing his schemes on dimension alone, diffusion alone, or combining the several points of his knowledge for any number of interesting applications.

Harmony and Attraction

In the study of color harmony proper, it is found that there are two large main divisions to consider—harmony and attraction. Simply, most color effects are based either on the arrangement of color with reference to analogy, or to arrangements based on contrast. Analogous schemes can more or less be termed "harmonious." Opposite schemes may be termed "attractive." Both types may have an equal appeal; but because the principles of analogy differ to some extent from the principles

*The Practical Side of Color Theory as Applied to Textile Design, The Melliand, Vol. II, No. 2.

Some Important Illusions of Color in Textile Design, The Melliand, Vol. II, No. 5.

tion bands. A photograph of the instrument is shown in Figure 1 and the essential features of its construction and operation in Figure 2.

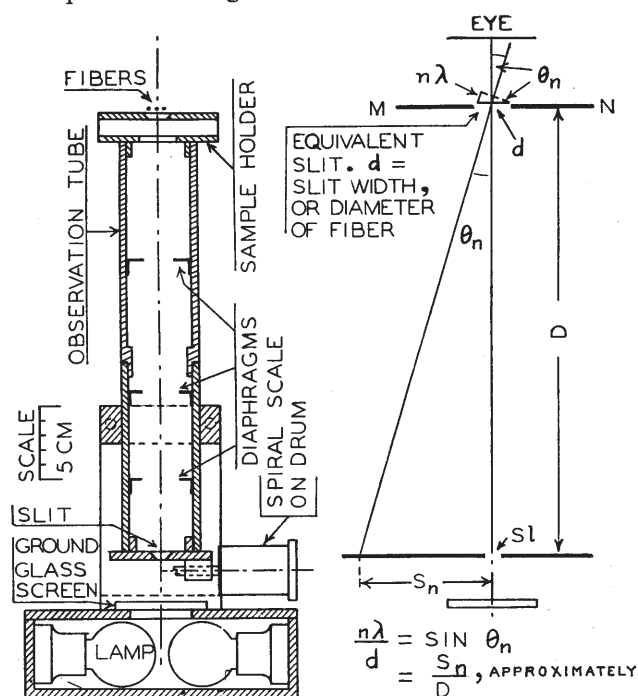


Fig. 2. Diagram of the Eriometer. The formula of the instrument is developed for a single fiber, or fiber element, of uniform diameter d . The quantity S_n is the measured distance from the center of the illuminated slit S_i out to the center of the n th dark band; θ_n is the corresponding angle of diffraction, and λ is the wave length of light. The constant of the instrument is ϵD , which is determined experimentally for this instrument by measurements on fine wires of uniform and known diameter. The same formula holds for a group of fibers of varying diameter, by virtue of the automatic superposition within the instrument of many separate optical effects arising from diffraction at different elements of fiber length in the group. The result of the measurement is then the average diameter of the group of fibers

At the lower end of an upright observation tube is a rectangular slit S_1 , approximately 1 mm wide and 15 mm long. This slit is illuminated through a ground glass diffusion screen by 4 ten-watt Mazda lamps, mounted in a white-lined box which forms the base of the instrument. The narrow illuminated slit serves as a uniform line-source of light for the observation of the diffraction phenomena.

At the top of the tube is a circular aperture, 6 mm in diameter, over which a group of 15 to 20 fibers may be mounted and arranged approximately parallel to the slit. To assist in this adjustment, the sample holder may be rotated about the axis of the observation tube.

Looking through the fibers at the illuminated slit one sees then a series of bright diffraction bands, separated by narrow darker intervals. These bands are arranged parallel to the illuminated slit and are extended laterally and symmetrically on both sides. From the theory of diffraction it is known that the distance from the

center of the bright slit to the first dark band on either side, is—to a close approximation—inversely proportional to the average projected diameter of the fibers.

For the purpose of measuring this distance the slit is actually made up in three parts. By means of a screw of known pitch the short outer parts of the slit (approximately 1 mm in length) may be displaced, simultaneously and laterally, relative to the central stationary part, until they are lined up with the center of the first dark band. This displacement, or its reciprocal value, is then read directly from a spiral scale on the drum. The relation between diameter and scale reading is given in Figure 2.

In a study of the performance of the instrument, diameter measurements have been made with the eriometer and with a microscope on wool and other textile fibers. The samples studied covered a range of average diameters from 13 to 50 microns.

From the microscope measurements on 12 wool samples diameter-frequency distribution curves were obtained, illustrating the wide range and varied distribution of diameters which may be collected into a single averaged result by the eriometer. On the average, this range of variation extends to ± 40 per cent from the mean, with an average deviation of roughly 10 per cent. The diffraction method is not suitable for the averaging of all possible diameter distributions. It is inherent in the method that the diameter distribution curve should not be very flat or irregular. For the best results there should be a pronounced concentration of diameters about the mean.

Within the range of applicability of the instrument, it is found that the precision and accuracy obtainable is quite sufficient for the intended purpose. The eriometer averages, for the samples studied, all fall within 2 microns of the corresponding values obtained by averaging many individual determinations with the microscope.

An investigation has been made of sources of error arising from irregularities in form and orientation of the fibers, such that the theoretical condition of parallelism between the fibers is not fulfilled closely. This possibility of error may be reduced to negligible proportions by reasonable care in the mounting of the fibers, and is not regarded as of serious practical importance.

A complete description of the instrument and its operation will appear shortly in the Bureau of Standards Journal of Research. In this paper, further developments in the construction of the eriometer are outlined by which a greater total length and number of fibers may be observed, and some quantitative information on the dispersion of diameters obtained. On the whole the diffractive method appears to afford considerable opportunity for the further development of instruments to include these additional desirable features.

of contrast, an establishment of these two main divisions of harmony and attraction will aid in giving greater clarity to the study.

Analogies of Tone.

Color harmony based on analogy has three typical classifications: the analogies of tones; the analogies of colors; and the analogy of a dominant color.

The analogy of tone refers to the use of one color in various tints and shades, or to several colors in one specific tint or shade. Beauty with one color can be exceptional if some diversity is shown in the selection of tints and shades. Gingham, for example, have to some extent exploited the possibilities of the one-color scheme. Where the single hue runs solid it gains full purity. Where it mixes in with white it attains an interesting tint which remains analogous to the pure color. On the other hand, several colors can be selected and harmony planned by making them all of one specific tint, shade or tone. In other words, colors do not have to differ from each other in black and white contrast in order to appear different to the eye. This fact is not always appreciated. A blue and a yellow can be identical in tone by making the yellow dark and the blue light, so that they both approach the same "gray" quality—yet the two tones will differ because the characters of the colors differ.

Refer to Figure 1. On the circular color band of the chart the various colors are located with reference to their "lightness" and "darkness." Yellow is at the top nearest white; blue is at the bottom nearest black. In gaining a harmony of tone, all the hues are adjusted so that their tone approaches the tone of one particular gray placed at a point somewhere between white and black. In Figure 1 this particular point has been established in the very center of the chart—at a "middle" gray. Thus the band running horizontally across the chart consists of a yellow that has been darkened, an orange and a yellow-green that have been darkened, a red that is slightly orange, a green that is slightly blue, a blue that has been heightened toward white, and a violet and a blue-green that have also been heightened.

In brief, this horizontal band in Figure 1 shows eight colors that all have the same "gray" quality, for all are placed at an equal distance between white and black. Yet the red and the green are fairly brilliant; orange, violet, yellow-green and blue-green are slightly grayed; and yellow and blue are considerably grayed, one mixed with much black and the other with much white. All harmonize because all present to the eye one consistent feeling of uniformity.

This principle of harmony lies in this subtle analogy of tone. It offers many beautiful color schemes of a sedate and mellow nature. It is worthy of much ex-

perimentation, although it is one of the most complicated methods of harmony.

Incidentally, harmonies of tone introduce the study of color balance. When the eye visualizes color it likes to see order. It is agreeable to the mellow combinations of adjacents, the striking contrast of opposites—and to the correct balance of light and dark. Color balance, briefly, is the arrangement of three or more colors so that a final ratio of 0-50-100 is maintained with reference to black, white and gray. The best description of this will be found in an example. A perfectly balanced scheme would consist of black, white and an orange-red. The black would be the 0 element, the white would be the 100 element, and the orange-red—which lies on the color chart (Figure 1) midway between black and white

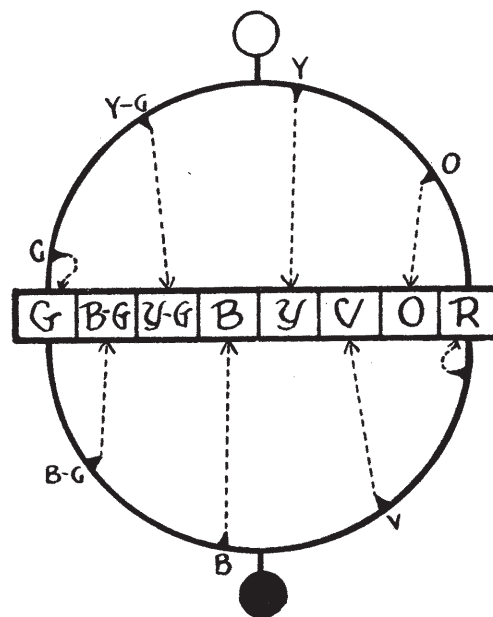


Fig. 1. Illustrating the Analogy of Tone. In the above chart a band of hues is located midway between white and black. All hues are fixed at this particular level: yellow, orange and yellow-green are lowered in brightness; blue, violet and blue-green are heightened; red is shifted toward orange, and green is shifted toward blue. Harmony lies in the consistency of tone with reference to a similar gray quality

—would be the 50 element. In such a combination the eye senses an agreeable balance because the orange-red is as far removed from the white as it is from the black. This same plan can be carried out even though black and white are not included. The trick is to maintain the 0-50-100 ratio and to see that the colors are located in tone at equally distant steps from each other with reference to differences in "lightness" and "darkness."

Analogies of Colors.

The second classification under color harmony, the analogies of colors, includes the beauty that is attained when the arrangement is planned with respect to adjacents. This has been described to some extent in

previous articles. Adjacent colors—colors that are related in character—harmonize because of their analogy. A scheme with red, orange and violet is harmonious because all hues contain red. Violet with red and blue is also harmonious, because violet is a hue that consists of red and blue. And so with orange, red and yellow; blue with violet and blue-green, and so on. Where a sure harmony is wanted, adjacents can be used satisfactorily. Their great advantage is that combinations of them always remain of one dominant color personality—either warm or cool, active or passive.

Analogy of a Dominant Color.

The third classification under harmony, the analogy of a dominant color, refers to the diffusion of a colored thread throughout a textile in order to bring all colors into one related tone. This also was described in a previous article. Simply, if some color selections are rather gaudy and bold, they can be brought into agreement by diffusing a colored thread—preferably one which has some relationship—throughout the entire material. For example, a red pattern on a blue background may be confusing to the eye, perhaps because one hue is advancing and the other retiring. To adjust such a scheme, a violet or lavender thread could be woven throughout, bringing the red toward a purplish tone, and the blue toward a purplish tone. Harmony is forced because the dominant thread mixes in with the other colors and shifts them toward itself.

In the second main division, color attraction, there are also three simple classifications that more or less encompass all color schemes which are planned to attain contrast. These three classifications are, contrast of brightness; contrast of purity; and contrast of colors.

Contrast of Brightness.

The first two classifications in this division are simple to understand. They involve principles of contrast that are opposite in character to the effects gained in the first classification of harmony—analogies of tones. That is, contrast of brightness means a selection of hues, tints and shades that show large difference with respect to white and black quality. Such schemes gain

their effectiveness through a lively stimulation of the eye—"checkerboard" effects in which good contrast exists in light and dark opposition.

Contrast of Purity.

Contrast of purity, the second classification under color attraction, is the contrast of colors with reference to brilliance. Pale hues with extremely pure hues often are quite beautiful—whether the colors are similar or opposite. It has been brought out in a previous article that a pure color displayed with a dull color will appear more pure because of the contrast, and the pure color will make the dull color appear yet more dull. Thus, if one particularly beautiful color is to be brought out in all its majesty, it most likely will show to best advantage on a background that is dull in tone and preferably of opposite character. And if the quality of dimension is respected, the contrast will be all the more striking.

Contrast of Colors.

Contrast of colors, the third classification under color attraction, involves the use of pure colors that are as far removed as possible from each other in character. The opposites in vision are red and green, yellow and blue, orange and blue-green, and violet and yellow-green. Opposites, of course, are most striking to the eye. In textile design they offer many possibilities in materials which must be crisp and startling in appeal. They find their best use when applied with respect to dimension, using the warm colors for foregrounds and patterns, and the cool colors for backgrounds.

Thus the simple principles of harmony given in this article more or less surround the several types of effects which the textile designer can hope to attain. Color cannot be greatly exploited. New colors cannot truly be invented, for the spectrum exists today as it has existed for centuries. Unusual effects are limited mainly to colors that have not been granted much attention, and to arrangements of colors that have not before been conceived. The devices presented in this article should aid in finding those colors and those unusual color arrangements.
