The Practical Side of Color Theory as Applied to Textile Design

By FABER BIRREN, CHICAGO, ILL.

In no other field is there such specific need for the study of color theory as in the textile industry. Few textile designers understand the laws of color that embrace their endeavors. Few text books cope with the individualities of color use typical to textiles. Consequently, much confusion exists today; and until the textile designer acquires a good and intelligent knowledge of his mediums of colors and yarns, he is not likely to conquer the secrets of maximum color appeal possible in his industry.

For the most part, a great deal has been written on the intricacies of dyes and dye combinations. The red-yellow-blue theory of color primaries is generally known. Yellow and blue dyes mixed together form green. Red and blue form purple, and so on. This is all fundamental information, but it contemplates a fairly simple law of color mixture that does not by any means encompass all the problems of the textile designer.

The big uniqueness found in this industry centers around, not the physical mixtures of colored dyes, but the visual mixtures of colored threads. In other words, yellow and blue dyes mixed together may form a green dye; but yellow and blue strands of thread woven together and diffused (mixed) by the eye will not form a green sensation. In this latter instance there is a serious departure from the red-yellow-blue law of color mixture, for the

EDITOR'S NOTE: This is the first of three articles by Mr. Birren which are aimed to assist textile designers in making better use of color. While it naturally opens the subject with a discussion of color theory, it brings out a number of practical applications. The visual aspects of color study are rather new in color literature and an understanding of them is essential to successful textile design. In the second article, which will appear in an early issue, theoretical ideas are departed from and emphasis is placed on pertinent color facts. The concluding article of the series will summarize color harmony suggestions and will be of great practical value.

problem has gone from the effect that takes place when one dye is mixed with another to the effect that takes place when one color is diffused with another color by the eye. Simply, an adequate study of color in textile design must take into consideration the visual aspects of color mixture as well as the chemical aspects of dye combinations.

There is large value in the study of color theory as applied to textile design. Certainly it is essential to understand that one set of color laws will not answer all problems. And if there is more than one theory to consider, the discrepancies of those theories will aid in establishing a more thorough and sound textile art. Many of the bewildering inconsistencies of color will be straightened out, and the designer will be equipped with a surer knowledge of limitations and possibilities.

Literary sources of color theory are likely to prove complicated. In one volume the problems of the physicist, who uses the medium of light, may be so treated as to overshadow the problems of the artist who uses pigments, or the textile designer who uses dyes and strands of thread. Other volumes may reverse the procedure. Thus to straighten the matter out it is well to give a bit of thought to the study of color in general and then to make deductions as they relate specifically to textiles.

Three Aspects of Color

Color can be studied from any one of three aspects—physics, pigments, vision. In Fig. 1 is a color band that consists of the four common colors, red, yellow, green and blue; and the four common color-blends, orange, yellow-green, blue-green and violet. This chart can be conveniently used as a basis, and the various primaries of the three aspects of color established thereon.

In Fig. 2 the physicist's triad, consisting of the three primaries of red, green and blue, is

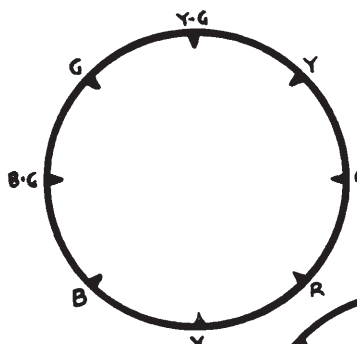

Figure 1. The color band consisting of the four common colors—red, yellow, green and blue — and the four common color-blends — orange, yellow-green, blue-green and violet.

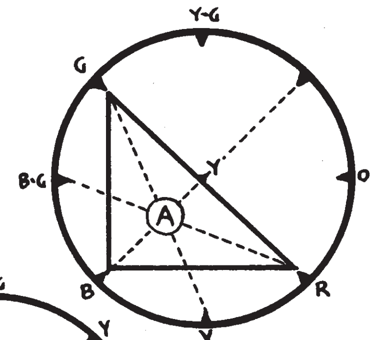

Figure 2. The triad of the physicist imposed on the color band showing the three physical primaries of light — red, green and blue —and their relationships.

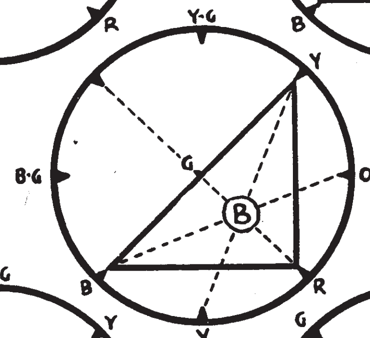

Figure 3. The triad of the pigment colorist, showing the three pigment primaries—red, yellow and blue—and their relationships. This chart portrays the laws of dye mixtures.

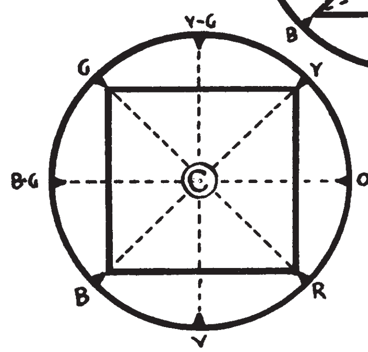

Figure 4. The tetrad of vision, showing the four visual primaries — red, yellow, green and blue. This chart is important in textile design, particularly with reference to the mingling of colors in weaves.

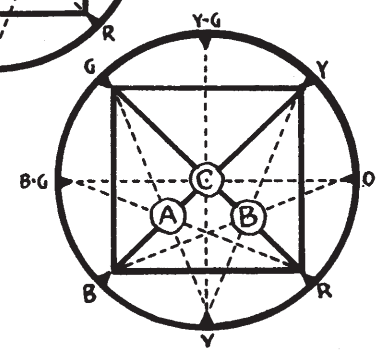

Figure 5. The physical and pigment triads, and the visual tetrad imposed simultaneously on the color band. Valuable in comparing the three aspects of color study, and in showing differences in primaries and opposites.

imposed on the color band. Here is a graph of color facts as they relate to the study of light rays and their mixtures. For example, mixtures of red and green light rays form yellow; red and blue form magenta; and green and blue form a blue-green. All this is indicated on the triad in this figure. As to opposites, complementation point A establishes them as red and blue-green, green and violet, and yellow and blue. Thus, from the standpoint of physics and light rays, the real theory of color rests with the points brought out in this chart (although the information has no bearing on the use of color in textiles).

In Fig. 3 the triad of the pigment colorist is imposed on the color band. Its three primaries are red, yellow and blue. In combination red and yellow form orange, red and blue form violet, and yellow and blue form green. Complementation point B in this figure establishes opposites as red and green, blue and orange, and yellow and violet. These facts relate to the mixtures of pigments and dyes. Opposites, of course, will always deaden each other.

In Fig. 4 a tetrad consisting of four primaries—red, yellow, green and blue—is imposed on the color band. Here is a third set of primaries that represents the fundamental factors encountered in the study of color as it relates to vision. In this chart the primaries of red and yellow combine to form orange, yellow and green form yellow-green, green and blue form blue-green, and blue and red form violet. Complementation point C establishes opposites as red and green, yellow and blue, orange and blue-green, violet and yellow-green.

For convenience in comparing the three aspects of color study, Fig. 5 shows the triad of physics (light), the triad of pigments and dyes, and the tetrad of vision imposed simultaneously on the color band. This chart will serve to reveal the various discrepancies of color facts encountered in these three viewpoints. Likewise, the complementation points, exhibited together, will indicate those differences in color opposites which affect the work of the physicist who uses light rays, the artist who uses pigments, and the textile designer who uses a weave of colored threads as his medium.

Visual Diffusion of Colors

The chart of color relationships in vision (Fig. 4) reveals a series of facts that are greatly overlooked by textile designers. Too often the red-yellow-blue law of color mixture is totally accepted, inasmuch as it rules the chemical reactions of dyes in combination. But the textile problem does not end here. To be specific, when dyes are mixed the result is always a chemical reaction that is experienced by the eye as a result. Yellow and blue dyes form green, and the eye sees the result as green. On the other hand, the same result does not hold true when the mixture becomes a visual one. For example, if yellow and blue strands of thread are woven together into one common surface that is fairly opaque, the eye in diffusing them into one sensation sees a result that is *gray,* not green. This is because in the visual relationship of hues, yellow and blue are opposites, and when mixed by the eye they deaden each other and a neutral gray tone results.

This leads to an important fact to be considered in textile design. When colors of opposite character are isolated from each other in comparatively large areas, the contrast to the eye is entirely evident and consequently entirely striking. But when colors of opposite character are *diffused* by the eye—closely woven, for example, from two or more contrasting colored threads—the force is wholly compromised. One color works against the other, and instead of contrast, the result is toward dullness and muddiness of tone.

Refer to Fig. 6. The left portion is made up of equal areas of black and white squares—50 per cent of each. Here there is obvious contrast, for the eye can readily distinguish the squares and compare them, one against the other. Then in the right portion of the figure the 50-50 proportions of black and white are maintained, but now diffused so that the eye can no longer keep them isolated. Here, instead of contrast, the effect is wholly subdued.

This demonstration is typical to textiles. When colors are isolated in comparatively large patterns which the eye can readily distinguish, it is easy to gain contrast, and opposite color combinations are most strong. But when similar selections of strong hues are closely woven together, an opposite effect results. Red and green squares, for example, would be striking to the eye; but red and green threads woven together would result in a tone of muddy, brownish gray.

The diffusion of colors in textiles thus demands a knowledge of the visual relationships of colors as revealed in Fig. 4. This chart should be known to the textile designer, for it more or less is graphically indicative of results that follow when colored threads are woven into one common surface. Yellow and blue do not make green—as they do in dye combinations—but gray. Red and green make gray. And so with orange and blue-green, and violet and yellow-green.

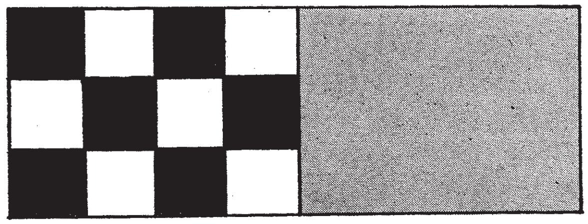

Figure 6. Showing how the application of color qualifies effect. A 50-50 proportion of black and white exists in both portions of the above figure. Contrast in the left portion is evident because of an isolation that is readily distinguished by the eye. In the right portion, when the same proportions of black and white are diffused by the eye, the result is quite dead and contrast is lost.

Summary

Here is a summary that adequately describes the facts brought out in the above discussion:

1. When colors are isolated in fairly large areas, contrast is evident and opposite groups can be used for utmost force.

2. When colors are diffused, contrast is lost, and the stronger the opposition of hues, the weaker the result.

3. No one set of rules thus encompasses all color schemes in textiles. Every application must be worked out in accordance with the manner and nature of its color arrangement.

With these points in mind the major effectiveness of color in textiles becomes a matter of deduction. In patterns, printed or woven in large areas, it is easy to gain contrast or harmony because the eye finds no trouble in distinguishing color differences. Force can be gained through such combinations as red and green, yellow and blue. Modulated harmonies may come with selection of red and violet, yellow and yellow-green, blue and blue-green, and so on. Choice is greatly optional, depending on the effect desired.

When, on the other hand, the colors are selected and planned for combinations in a close weave, the principles of diffusion will have to be considered, and the chart shown in Fig. 4 kept in mind. Here opposite schemes will result in muddiness, for when the eye mixes color on its retina, the stronger the contrast, the weaker the result.

Yet excellent color power is possible through diffusion. Such combinations as red and violet, blue and violet, green and blue, and so on —where the scheme is arranged with reference to analogy—will show up to unusual advantage. Adjacent colors diffused by the eye remain strong in color character. A weave consisting of red and violet, for example, remains dominantly red in character, and the diffusion that results tends to create a most vivid and beautiful clarity. In this case no opposition exists to produce grayness. Instead, the eye reaches a compromise, and the compromise is between colors that are similar.

Color theory as applied to textiles thus has its value in equipping the designer with an exact understanding of limitations and possibilities. If the few facts here discussed are appreciated, a great deal of experimentation will not be necessary, and possible effects can be anticipated with surprising accuracy.