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Achieving Harmonious Colour Relationship in Art/Design: Towards a Mathematical Model

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Abstract

Achieving harmonious colour relationship for visual expression is of prime importance in art and design. Mixing pigment colours is often unwieldy, ambiguous, confusing and problematic. Therefore, as a panacea, this paper proposes a mathematical model that would serve heuristic, descriptive, diagnostic, prescriptive, and predictive functions. It used a triangulation of the Critical-Historical-Analytical Examination, Artistic Exploration and Content Analysis methods. The paper started with the need for model to satisfactorily resolve problems associated with mixing colours in harmony. Furthermore, the fundamental features of colour were highlighted. Moreover, it discussed the adoption and adaptation of the Colour Wheel into a set of alphanumeric codes and mathematical proposition: nH(I+V) =1, where n is a number of a code that represents a type of colour harmony, H:Hue, I: Intensity and V: Value. The alphanumeric codes: M(1), A(1,2,3), DC(1,7), SC(1,6,8), NC(1,6 or 8), TR(1,5,9), B(1,6,10) and TD(1,3,7,9 or 1,4,7,10) represent Monochromatic, Analogous, Direct Complementary, Split Complementary, Near Complementary, Triadic, Balance, and Tetrad schemes respectively. And the paper ended with suggestions that artists and

designers should internalize and employ these codes and formula, which with practice, become intuitive and useful.

Key Words: Colour Features, Colour Mixing, Harmonious Relationship, Mathematical Model, Art and Design.

Introduction

> Color is knowledge and knowledge comes from studying the Munsell (*Colour Wheel*)… Study the principles of dominant colors, analogous, complement, monochrome. Don't be like the general population who think that color comes to them quite naturally.

The above citation is gleaned from Brown (2011:122), quoting Whistler; it emphasizes the need to diligently study the colour wheel in order to avoid creative block in colour usage and achieve harmonious colour relationship. This is necessary because there is confusion and prevalent ignorance of the logical, constructive, expressive and effective use of colour for aesthetic and functional purposes.

The study of colour in various fields: art, chemistry, philosophy, physics, psychology and psychophysics is premised upon its immense impact on humankind (Khouw, 1995; Milton, 2011; Koert and Brian, 2011). This, has led to development of a variety of theories, increased knowledge and the production of a wide-range of colour media that have enlarged our experience of colour to advance the work of art and design. However, this has created problem: confusion arising from the different and wide-range of colour concepts that are not kept distinct, contradictions embedded in colour semantics, complexity of colour itself and lack of consensus on primary colours. So, the artist or designer is often confronted with a number of uncertainties to be resolved on colour in the midst of exceedingly great variety of available concepts and materials. Willard (1998), aptly described this situation as "a dystopia of color education in a utopia of color experience".

The above situation, for example, could readily be seen among students and professionals in art schools and galleries respectively in Nigeria, where there is prevalent use of colour based on inadequate knowledge. A key way to satisfactorily resolve this problem and knowingly employ colour towards achieving desirable outcomes in visual expression is to strike a balance of the three attributes of colour (hue, intensity and value), using the colour wheel in a variety of ways to generate harmonious relationship.

Achieving harmonious colour relationship is traditionally lodged in the physical domain of colour study, which requires a thorough grasp of pigment colour mixing, physical appearance of colour and conditions that have bearing on it. However, mixing of colours in harmonious relationship is broad, unwieldy, ambiguous and often

confusing. This requires the intervention of simple and dynamic models that would serve heuristic, organizing, descriptive, diagnostic, prescriptive, and predictive functions.

A model (functional, graphical, mathematical, structural or verbal) is a consciously simplified description of a piece or reality that seeks to show the main elements of any structure or process and the relationship between these elements. According to McQuail and Windahl, 1986:2, model serves the following purposes:

Firstly, they have an organizing function by ordering and relating systems to each other and by providing us with images of wholes that we might not otherwise perceive. Secondly, they help in explaining, by providing in simplified way information, which would otherwise be complicated or ambiguous, thereby performing a heuristic function of providing a guide to key points of a process or system. Thirdly, the model may make it possible to predict outcomes or the course of events.

A model that describes/prescribes a sure method to achieving harmonious colour relationship is indispensable in art and design. It would be a crucial guide for artists and designer to key points of the colour wheel when making choices on colour/combination of colours to generate desired result. Also, it would provide the much needed knowledge to handle a range of different particular circumstances in the use of colour to resolve uncertainties in visual expression and communication. This is particularly so when the model could easily be internalized and become intuitive through practice.

The adaptation of ideas, processes, structures or systems to a set of numbers in art and design is not new. Since the renaissance period, for instance, simple, rational, irrational and sequence numbers have been employed in solving problems of composition and design in art. Examples include the Fibonacci Sequence - a sequence of numbers whereby every number is the sum of the preceding two (1, 2, 3, 5, 8, 13 etc.); the Euclid Golden ratio - a ratio within the elements of form, such as height to width that approximates 0.618; and the Golden grid - whereby a surface is divided into thirds that is similar to the Golden ratio but resulting in an approximation of 0.666. These numeric approaches were attempts to establish mathematical models aimed at creating aesthetic positions for the elements of prime importance in order to make pleasing visual composition. Equally important, unwieldy and complicated as composition, is colour.

Therefore, a mathematical model would be an appropriate structure to providing invaluable guide for resolving challenges associated with achieving harmonious colour relationship for visual expression and communication.

Towards a Mathematical Model – The Key Variables

Usually, a mathematical formula is made up of two or more variables. The model proposed here consists of two major variables: the features of colour, and the Codes for harmony types.

The three key features of pigment colour: Hue, Intensity and Value (H, I and V respectively) constitute a major component of the formula: nH(I+V)=1; where nH stands for the number of hue in the Colour Wheel that is selected. While (I + V) stands for the intensity and value ranges of the hue selected.

The alphanumeric codes for various types of harmonious relationship form the other major variable of the mathematical proposition. These codes include M(1), A(1, 2, 3), DC(1, 7), SC(1, 6, 8), NC(1,6 or 8), TR(1, 5, 9), B(1, 6, and 10) and TD(1, 3, 7, 9 or 1, 4, 7, 10). The alphabet(s) before the number(s) in bracket represent Monochromatic, Analogous, Direct Complementary, Split Complementary, Near Complementary, Triadic, Balance, and Tetrad-Double/Paired Complementary schemes respectively.

Features of Pigment Colour for Harmonious Relationship

The three attributes of colour for Harmonious colour relationship are: hue, intensity and value. The attribute of hue is usually combined and modified with intensity and value to generate a harmonious whole.

The hue is the fundamental attribute on which the rest attributes are based. It is depicted in the colour wheel (Figure 1).

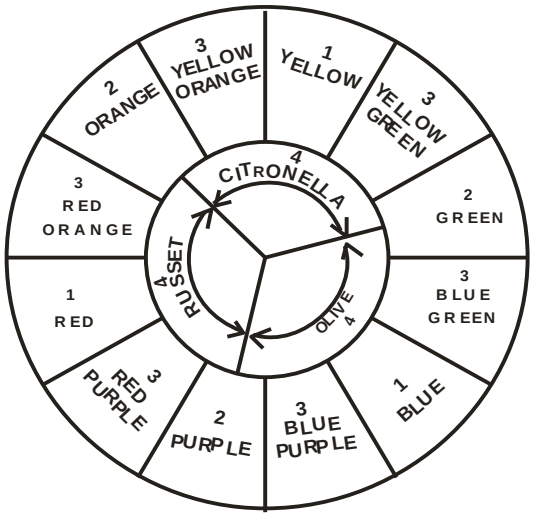


Figure 1: Showing the Pigment Colour Wheel: 1 Primary, 2 Secondary, 3 Intermediate and 4 Tertiary hues

Hue is the description of the basic colour - the specific wavelength of light rays reflected. One hue is different from another. Red is a different hue from Yellow and Blue is different from Orange as examples. Hue is the quality of colour that lay persons call colour. Often, hue is combined and modified with intensity and value. The intensity, saturation or chroma is the degree of dullness or brightness of a hue, while value is the lightness or darkness of a hue (Figure 2).

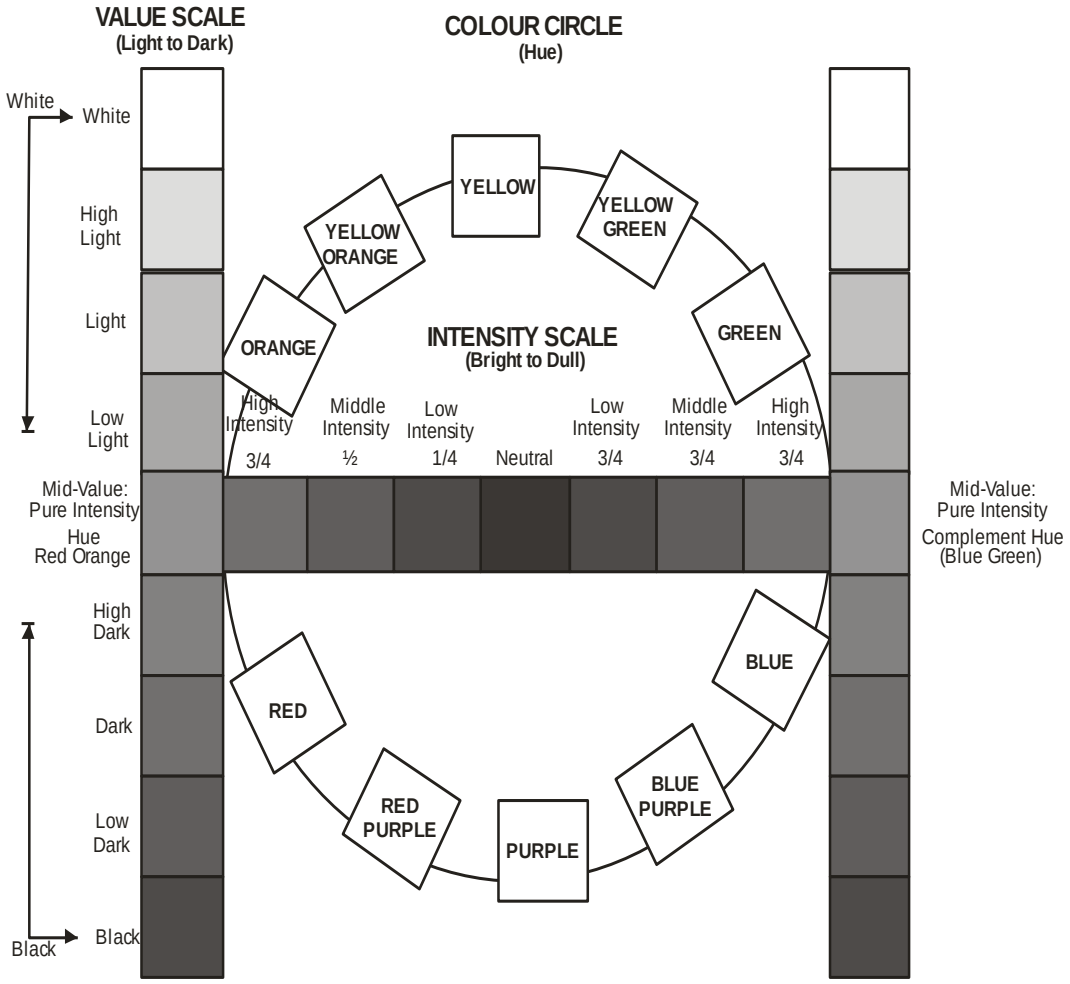


Figure 2: Showing the three attributes of colour-Hue, Intensity and Value (After Quiller, 1992: 25)

An understanding of the three attributes of colour is important for the artist and designer in order to create exciting and dynamic visual expressions in colour. The three attributes: hue, saturation/intensity and value need be employed to achieve drama. Reid (1993), states that a key challenge in the production of good colour work is to strike a balance among the attributes. This balance is not in terms of equal proportion but of relative dominance. Dobie (1992:36) states that equal amount of colour in a mixture create lifeless result and to create lively luminous result "the secret is to keep the ratio of pigments in the mixture unequal". It is this unequal relationship, the interplay of large and small amount of hue, chroma and value contrast that generate visual interest.

Therefore, the basic mathematical proposition here: nH(I+V)=1, comprises these three features of colour, where n is a number of an alphanumeric code for a harmony type, H:Hue selected from the colour wheel, I: Intensity variations of the selected hue and V: Value variations of the selected hue. The interface of these attributes within the context of the numeric codes, derived from a critical analysis of the colour wheel, result in a harmonious whole (=1).

Alphanumeric Codes for Harmonious Relationship in Colour

Generally, harmonious colour relationship could be classified into two: related and contrasted. Specifically, monochromatic and analogous colour schemes are related harmony while complementary, triadic and tetrad/quadratic colour schemes are contrasted harmony. These harmony type could be simply described and prescribed with a set of alphanumeric codes based on the colour circle.

Monochromatic Scheme (M: 1)

Monochromatic scheme is the use of tints, tones and shades of a hue. The number for the monochromatic scheme is 1 (Figure 3)

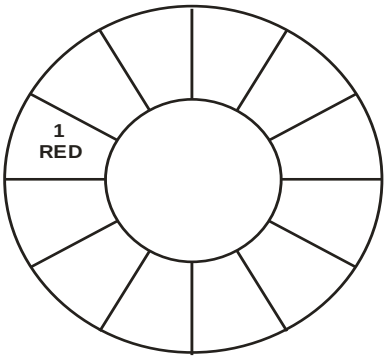


Figure 3: Showing the monochromatic colour scheme

The number, 1 represents any hue selected from the colour wheel. The hue could be then combined with its modifiers - intensity and value nuances. For instance, if the hue selected from the colour wheel is red. Red is 1. Red is combined with its modifiers (intensity: variably neutralized with its complement – green; and value: variably neutralized with White-{tint}, and Black-{Shade}). This is achieved in practice thus: red is modified to produce - neutral, ¼ intensity, ½ intensity, ¾ intensity, and full intensity. The neutral is achieved by admixture of red and its complement green at equal proportion, then the intensity is increased by a quarter volume of red until it becomes 1- full intensity - the pure hue. Also, the modification of the value of red produces high light to low dark values that range from white through red at medium value to black (see Figure 2).

The combination of the hue, its four tonal variations in terms of brightness and dullness as well as its nine variations in value in terms of lightness and darkness present a wide-range of possibilities in expressing an idea with the monochromatic colour scheme. The possibilities assume a limitless range when organised according to the principles of organisation. For example, the principle of dominance; imagine making one visual expression of every value of red in the value scale and every tonal variation in the intensity scale as the predominant in a given visual expression. This would provide a minimum of thirteen visual essays of red. So, using the monochromatic scheme, applying the principle of dominance alone, of all the hues in the colour wheel would result in varied one hundred and fifty-six visual passages.

The pleasing effect of the monochromatic scheme could be seen in the tonal and value variations of a single-colour medium. Here, a gray is used to visually illustrate a social event in the Niger Delta region of Nigeria (Plate 1).

Aro Oge 2012 Charcoal on Paper 20” X 25”

Plate I: Showing Illustration based on (M:1) by Ebigbagha S. Z

Analogous Scheme (A: 1, 2, 3)

Analogous scheme involves the use of two to three colours adjacent to one another on the colour wheel (Figure 4). The code for the analogous scheme is A (1, 2, 3).

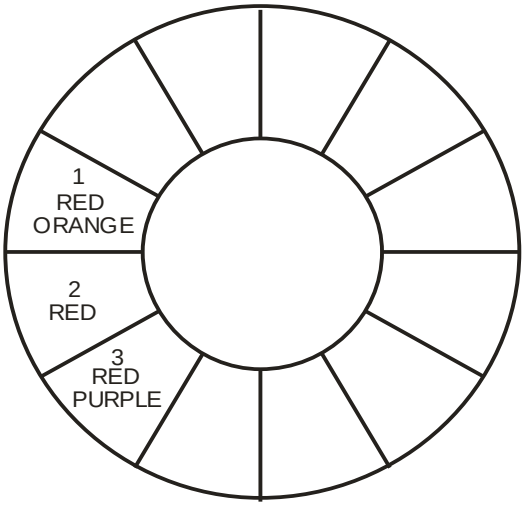


Figure 4: Showing the analogous colour scheme

The number, 1 represents any hue selected from the colour wheel and the two colours that are adjacent to it, 2, and 3 respectively. Using our general formula of nH(I+V)=1, the analogous scheme could be expressed thus 1H(I+V)+2H(I+V)+3H(I+V)=1. If number 1 is red orange (RO) then 2 would be red (R) and 3 would be red purple (RP). So the formula when applied on palette would be RO(I+V) + R(I+V) + RP(I+V) = 1. A visual expression that is derived from the combination of red orange, red and red purple and their intensity and value scales would be harmonious. The number of visual expressions that could be generated with this scheme from the colour wheel without repetition of colour far exceeds one hundred and seventy four in a given round.

The beautiful effect of the analogous scheme could be seen in a combination of Yellow, yellow orange and Orange (Plate II), which visually illustrates an agricultural event in the Niger Delta region of Nigeria.

Tonbrapade 2012 Oil on canvas 48" x 60"

Plate II: Showing illustration based on (A:1,2,3) by Ebigbagha S.Z

Direct Complementary Scheme (DC:1, 7)

The direct complementary scheme uses two hues that are directly opposite each other in the colour wheel (Figure 5). The alphanumeric code for direct complimentary scheme is DC (1, 7)

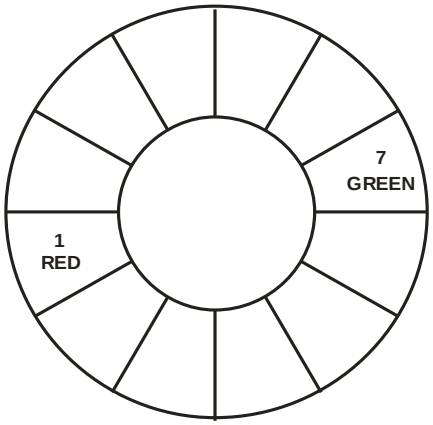


Figure 5: Showing the direct complementary colour scheme

Choosing any colour to start with, 1 then the seventh colour from it is the complement. For example, if 1 is red, then the seventh is green, so using the formula of nH(I+V) =

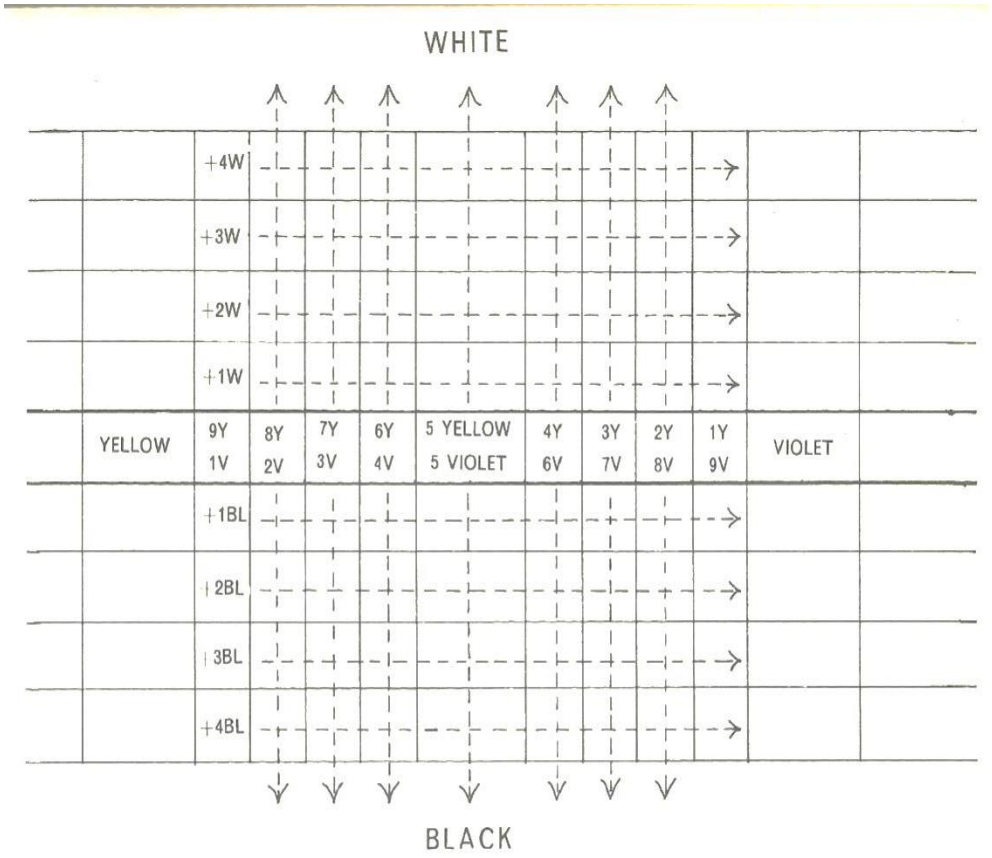
1. 1(I+V) + 7(I+V) =1. Therefore, R(I+V) + G(I+V)=1, will produce harmonic relationship(Plate III).

Ebinamadioweimo Namamo 2014 Oil on canvas 18" x 24"

Plate III: Showing illustration based on (DC:1,7) by Ebigbagha S.Z.

The intensity and value scales of red and green, like all other pairs of complementary colour, present a wide-range of options that can be used to create a large number of visual expressions. Maurice (1978: 83), lucidly presents this in a graphic form using the direct complement of yellow and violet (as shown in Table 1)

Table 1: Showing a range of admixtures with direct complements (After Maurice, 1978:83)



In this table, the letter-symbols are as follow:

W = white

BL = Black

Y = Yellow

V = Violet

The numerical figures indicate the quantitative addition to each mixture

Split Complementary Scheme (SC: 1, 6, 8)

The split complementary scheme uses three hues: any chosen hue and the two beside its complement (Figure 6). The code for the Split complementary scheme is SC (1, 6, 8).

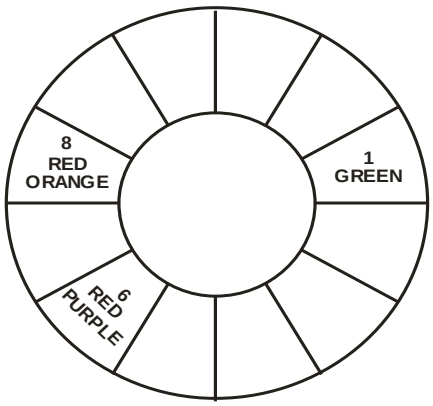


Figure 6: Showing the Split Complementary Scheme

From the above, where green is the chosen hue, for example, red orange and red violets are its split complement. The complement red is deliberately omitted to afford the two hues by its left and right sides. This in mathematical order is 1H(I+V) + 6H (I+V) + 8H(I+V)=1. So, using our example, G(I+V) + RO(I+V) + RV(I+V) =1, would translate into harmonious colour relationship. This could be seen in RO, B and G encoded in visual language as shown in (Plate IV).

Ezon Yerin Buo Oil on canvas 36" x 48" 2009
Plate IV: Showing illustration based on (SC:1,6,8) by Ebigbagha S.Z.

Near Complementary Scheme (NC: 1, 6 or 8)

The near complementary scheme utilizes two of the three hues of the split complementary scheme-the chosen hue and any of the hues by its complement. This could be expressed in alphanumeric form as follows. 1H(I+V) + 6H(I+V)=1 or 1H(I+V) + 8H(I+V)=1. Therefore, G (I+V) + RO (I+V) =1 or G (I+V) + RV (I+V) =1. This is depicted visually using Y and BV (Plate V)

Buburu Efie 1 2009 Oil on canvas 40" x 40"

Plate V: Showing illustration based on (NC:1,8) by Ebigbagha S.Z.

Triadic Colour Scheme (TR: 1, 5, 9)

The triadic colour scheme uses three hues that are at equal distance from one and another in the colour wheel (Figure7). The code for the Triadic Scheme is TR (1, 5, 9)

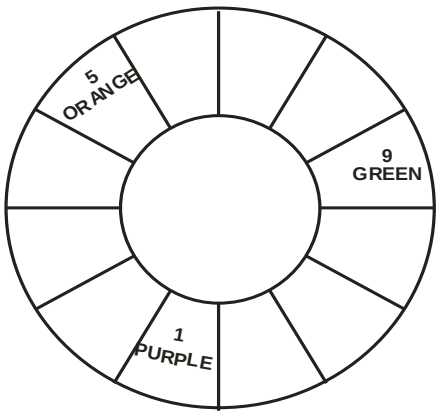


Figure 7: Showing the triadic colour scheme

The number 1 stands for any colour that is selected in the colour circle. Then the fifth and the ninth hue from the selected one constitute a harmonious relation when combined for visual expression. For example, were purple (1) is selected, orange (5) and green (9) would be taken as the other two hues for the triad. This mathematically translates to 1H(I+V) + 5H(I+V) + 9H(I+V)=1. Therefore, purple (I+V) + Green (I+V) + Orange (I+V) =1. The range of the intensity and value scales of the triadic scheme is enormous. The range of neutrals resulting from the combination of the three hues, the value scale of these neutrals, and the intensity and value scale generated by every one of the three hues is wide. Imagine the several triadic schemes is the 12 hue colour wheel and the almost limitless variations the gradation of every hue provides, it becomes clear that a great variety of harmoniously related art works/designs could easily be achieved with just applying the principles of dominance in the variation process, as in(Plate VI) using R, Y and B.

Ayaburu Oge 2005/06 Oil on canvas, 48" X 72"

Plate VI: Showing illustration based on (SC:1,6,8) by Ebigbagha S.Z.

Balance Colour Scheme (B: 1, 6, and 10)

The balance scheme is closely related with the triadic scheme in the sense that it uses three colours at different sections of the colour wheel. However, it is different because the hues are not equidistant but progressively decreased in the number of spacing between colours on the wheel by one in an order of 4:3:2. This could be interpreted ordinarily and explained thus: begin with the selection of any hue from the wheel (the 1st), then pass over 4 hues and select the next (the 6th), and then pass over 3 hues and select the last (the 10th). The result is the selection of hue 1, 6, and 10 in the colour wheel, as shown in (Figure 8). The code for the Balance Colour Scheme is B(1,6,10)

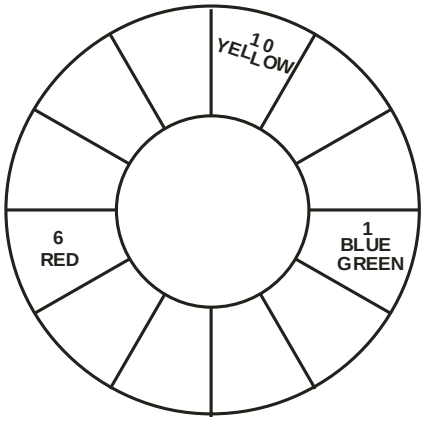


Figure 8: Showing the balance colour scheme

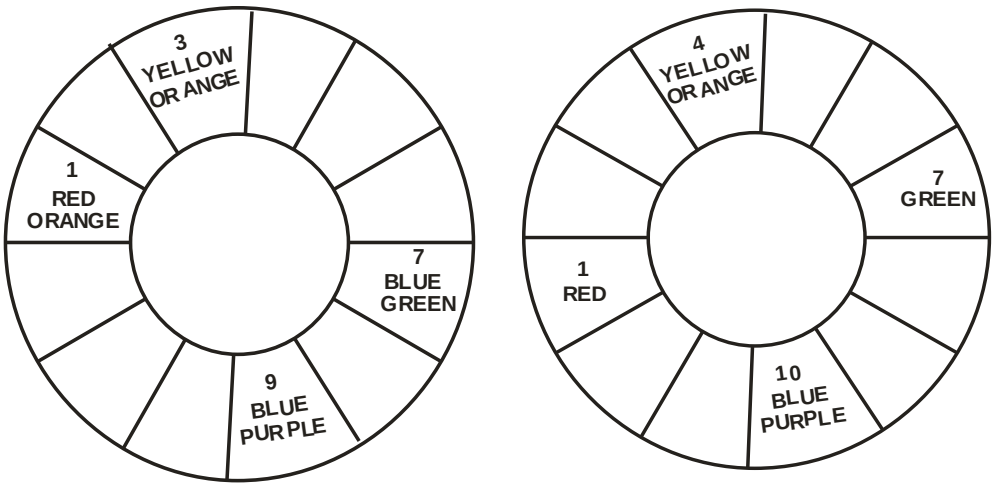
The application of the balance colour scheme using the formula nH(I+V) =1 is described mathematically thus: 1H(I+V) + 6H(I+V) + 10H(I+V) =1. If Blue Green is 1, Red is 6 and yellow is 10. Therefore, BG (I+V) + R (I+V) + Y (I+V) =1.The balance colour scheme is as dynamic as the triadic scheme. Its appeal is superb as expressed in graphic language (Plate VII) where Y, B and RV were employed.

Eta Yepoumene 2012 Oil on canvas 36" x 36"

Plate VII: Showing illustration based on (B:1,6,8) by Ebigbagha S.Z.

Tetrad Scheme-Double or Paired Complementary (TS:1, 3, 7, 9) or (TS:1, 4, 7, 10)

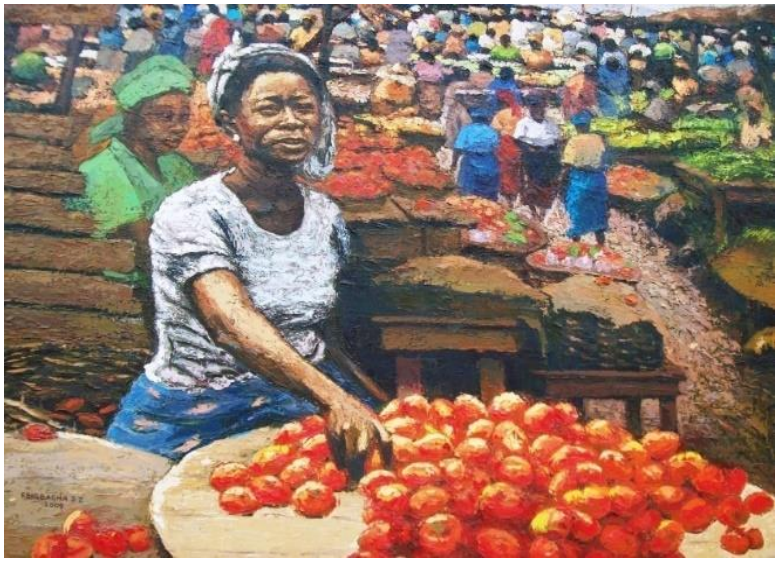
The Tetrad scheme uses two sets of complementary hues in the colour wheel in two ways (Figure 9a and 9b)



a b

Figure 9a and 9b: Showing the Tetrad Scheme (TS:1,3,7,9) or (TS:1,4,7,10)

One of the two ways mentioned above involves the number 1, 3, 7, 9, which produces a rectangle circumscribed in the colour wheel (as shown in Figure 9a). And the other uses 1, 4, 7, 10, which produces a square circumscribed in the colour wheel (as shown in Figure 9b). The harmonious colour relationship derived is often dynamic. Expressed in mathematical order following the general formula nH(I+V) =1, the first way could be expressed thus: 1H(I+V) + 3H(I+V) + 7H(I+V) + 10H(I+V) =1. Let us make Red Orange (RO) the first hue to be used on the colour wheel, so, RO is 1, then Red purple (RP) is 3, Blue Green (BG) is 7 and Yellow Green (YG) is 9. The second way could be equally expressed in mathematically order as follow: 1H (I+V) + 4H (I+V) + 7H (I+V) + 10H (I+V) =1. Let us assume we are starting with red on the colour wheel, so the hue Red (R) is 1, Blue Purple (BP) would then be 4, Green (G) would be 7, and Yellow Orange (YO) would be 10. Therefore, R (I+V) + BP (I+V) + G(I+V) + YO(I+V) =1. The aesthetics and functional value of this scheme in communicating visual messages is highlighted in Plate VIII.



Ogbo Fou 2009 Oil on canvas 48" x 60"

Plate VIII: Showing illustration based on (TD:1,3,7,9) by Ebigbagha S.Z.

The range of neutrals, number of gradations and hue is the largest in comparison with the other schemes for harmonious colour relationship already discussed. This becomes obvious when all the hues, intensities and values are expressed. So, the number of visual expressions that could be generated using the tetrad scheme is immense.

Achieving harmonious whole could be summed up in the following codes: M(1); A(1, 2, 3), DC(1, 7), SC(1, 6, 8), NC(1, 6 or 8), TR(1, 5, 9), B(1, 6, 10) and TE(1, 3, 7, 9) or (1, 4, 7, 10), which represent Monochromatic, Analogous, Direct Complementary, Split Complementary, Near Complementary, Triadic, Balance and Tetrad harmony respectively. Just as acronyms and mnemonic devices, which are methods of re-organizing information to aid rapid recall when needed, so is this simple formula of numbers and codes generated from critical analysis of the colour wheel. These alphanumeric codes have being invaluable in my approximately three decades of professional practice in visual communication.

Conclusion

A sufficient and necessary understanding of mixing pigment colour in harmonious relationship is crucial to overcoming challenges in visual expression using pigment colour. It ameliorates the excruciating pain associated with disapproval or outright rejection that often results from producing art and design with colours that are not harmoniously related. Generating colour in harmonious relationship is pivotal for

successful sharing of ideas, depiction of existing realities and effective expression of emotions in visual language.

A key way colour could be mixed and harmoniously varied at will, is the use of simple coded numbers (A: 123, DC: 17, TR: 159 and TD: 1379 to mention a few). This employed within the harmonious colour relationship formula nH(I+V) =1, is an invaluable strategy that certainly yields pleasing result.

The mathematical formula, nH(I+V) =1, need be internalized by artists and designers. It is a guide that explains, organizes and facilitates the mixing of colours in harmonious relationship. It adequately equips the artist/designer (whether in training or professional practice) with the knowledge and understanding to creatively, constructively and expressively use colour to achieve an overall desired goal. Even though the use of the formula might appear restrictive initially, through practice, it becomes intuitive and forms part of one's sensibilities with great benefits.

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