Colour Harmony Revisited

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Abstract: A plethora of theories and studies exist that focus on the relationship between colour and esthetic response as well as the construction of colour harmony. However, consensus regarding colour harmony is lacking in the literature leaving designers and architects with colour harmony information that is contradictory and ambiguous. This article examines both early and more recent theories and definitions of colour harmony. The diverse theoretical paradigms and disparate assumptions embedded within these theories are discussed in some depth, and the validity and veracity of predictive colour harmony theories are discussed from a current theoretical perspective. An updated definition of colour harmony is provided along with a conceptual model that represents an attempt to revise colour harmony in line with current theoretical paradigms. This conceptual model acknowledges that the interface between colour and esthetic response is less deterministic and predictable, and more idiographic than previous theories allow. In addition, the conceptual model suggests that colour harmony is contingent on factors that may influence the relationship between colour and esthetic response such as individual and cultural differences as well as perceptual, contextual, and temporal factors.

INTRODUCTION

A generally accepted understanding of colour harmony is provided by Burchett’s1 suggestion that “Colors seen together to produce pleasing affective response are said to be in harmony” (p 28). The simplicity of this statement belies the complexity behind attempts to define, explain, and predict colour harmony. A plethora of colour harmony theories, models, and formulae exist in the literature; however, as noted by Burchett1 and Arnkil,2 a lack of consensus exists regarding a definition of colour harmony.

The lack of consensus and ambiguity relating to colour harmony can be partly explained by the diversity of theoretical frameworks which underlie the various attempts to define, explain and predict colour harmony, and by the assumptions underlying these various attempts. This article examines the diverse theoretical paradigms and the disparate assumptions embedded within selected colour harmony theories (and related definitions, models, and formulae), and appraises the validity and veracity of these. From a current theoretical perspective, many early definitions of colour harmony appear simplistic or overly generalized in nature; or seem to be based on unfounded opinion or unsubstantiated claims. In response, a conceptual model of colour harmony is proposed that represents an attempt to define and update the construct in line with current theoretical paradigms.

DEFINING COLOUR HARMONY

Arnkil2 suggests that the range of theories corresponding to colour harmony is based on two key concepts: equilibrium or balance of opposites or opposing forces; and the overall unity of overall colour appearance. In addition, Arnkil suggests that colour harmony theories tend to fall into five categories:

1. The music analogy;
2. Visual comfort;
3. Balance of opposites;
4. Geometric or mathematical order;
5. Similarity or convergence of visual attributes.

In agreeing with Arnkil, this article recategorizes the various approaches to define colour harmony as follows.

In the first category, colour harmony is defined as a universal phenomenon that can be created and predicted via mathematically-derived proportion and order, as champ-
ioned by Newton, who proposed that colour harmony relied on proportional arrangement of colour/s similar to the ordered basis of musical composition and harmony:

... not only because it agrees with the phenomena very well, but also perhaps because it involves something about the harmonics of colors (which is) perhaps analogous to the concordance of sounds (Newton cited in Gage, Ref. 4 p 232).

From this Pythagorean esthetico-mathematical standpoint, every aspect of the universe (including esthetic response to colour) can be expressed in mathematical terms. Ostwald’s theories were underpinned by this esthetico-mathematical understanding as evidenced by his assertion “(colour) harmony is order” as well as his approach in achieving colour harmony which involved strict proportional colour combination (p 258). Likewise, Munsel's provided a set of four prescriptive rules based on (1) Hue (“use as few as possible”), (2) Value (“use a high value with a low value”), (3) Chroma (“use a strong chroma with a weak chroma”), and (4) Area (where “Area is inversely proportional to the product of value times chroma”) and suggested that “Colour harmony is attained when any three of the foregoing rules are followed” (Munsell cited in Cleland, p 19). Moon and Spencer's suggested that “any arrangement of colours that can be sensed as an orderly combination will be pleasing” (p 47). To assist with recognizing an orderly combination of colours, Moon and Spencer devised a formula for rating colour harmonies based on Birkhoff’s quantitative esthetic measure:

\[ M = \frac{O}{C} \]

where esthetic measure \( M \) is calculated by dividing the number of elements of order \( O \) by the number of elements of complexity \( C \). In Moon and Spencer’s formula, the factor of order \( O \) is represented by the components: colour identity (that is, basic colour category such as red or green), similarity, and contrast of hue, value, and chroma. The factor of complexity \( C \) is represented by:

\[ C = (\text{No. of colour/s}) + (\text{No. of pairs of colour/s with hue difference}) + (\text{No. of colour pairs with value difference}) + (\text{No. of colour pairs with chroma difference}) \]

By applying this formula to colour combinations of 2 to \( n \) pairs of colours, Moon and Spencer concluded harmonious combinations as those that achieve high rankings on their scale of esthetic merit. Their formula is highly complex and convoluted, and almost defies application. However, their article does provide esthetic measure ratings of a limited range of colour pairs and groupings.

More recently, Chuang and Ou defined harmonious as “that which please the viewer” in a study that focused on evaluating degrees of colour harmony among pairs of colours (p 30). Chuang and Ou used pairs of colour samples displayed on a computer monitor and adapted Moon and Spencer’s formula as a measure of esthetic response.

A second category aligns colour harmony with the notion of balance or equilibrium. For example, Goethe considered that colour harmony was represented by the totality of his colour wheel model which revolved around two key (opposing colours): blue and yellow. This approach to colour harmony is reminiscent of Heraclitus and later Pythagoras for whom the world was composed of opposing tendencies or forces, and where harmony within any aspect of reality involved the balancing of these opposing forces. This concept of balance, equilibrium, and the neutralization of opposing forces feature strongly in the colour harmony theories of Munsel, Chevreul, and Itten. For example, Itten contended that “(Color) harmony implies balance; a symmetry of forces” (p 21). Any combination of colours that achieved equilibrium in the eye equates with colour harmony.

Similarly Chevreul, championed “complementary” colours and their contribution to colour harmony and he “equated maximal contrast of the complementsaries with maximum harmony” (Chevreul cited in Gage, p 218). A number of Impressionist painters were influenced by Chevreul’s colour harmony theories as evidenced in the work of Monet (whose paintings are infused with pairs of complementary colours: blue/yellow-orange, red-green, purple-yellow/gold, light-dark) as well as Degas (who favored red-green and turquoise-peach/orange) and Seurat.

However, while the opponent-process theory of human vision involves pairs of “complementary” colours (red-green, blue-yellow, and black-white), there is no evidence to suggest that physiological “balance” in the human visual system is associated with positive esthetic response or colour harmony. The claims of Munsel, Chevreul, and Itten that colour harmony is predicated on the “balance” of contrasting or “complementary” colours remain unsubstantiated.

A third category suggests that colour harmony can be defined as groups of colours that exhibit similarity in terms of hue or tonal level. As Itten suggests, the color combinations called “harmonious” in common speech usually are composed of closely similar chromas, or else different colors in the same shades. They are combinations of colors that meet
without sharp contrast. As a rule, the assertion of harmony or discord simply refers to an agreeable-disagreeable or attractive-unattractive scale. Such judgments are personal sentiments without objective force. (Itten Ref. 18, p 21).

This definition of colour harmony is also shared to a certain extent by Munsell as well as Hård and Sivik who suggest that empirical evidence points to a link between analogous colours and positive esthetic response. Within these varying colour harmony definitions, theorists define and discuss colour harmony as an abstract, akin to Plato’s notion of ideal forms. However, to Arnkil, colour harmony is not an abstract concept but arises from the dynamic interface between the subject and object, the experience of which is common and universal degree but also contingent on “the cultural consequence of the human visions ecology and evolution” (p 268). Albers is one of a number of colour theorists who agree with this understanding of colour harmony, and he considered formulaic approaches to colour harmony to be inappropriate and that “no mechanical colour system is flexible enough to precalculate the manifold changing factors in a single prescribed recipe” (p 42). Similarly, Hård and Sivik acknowledge that responses to colour are constantly open to the influence of individual differences as well as cultural, contextual, and perceptual factors, and the complexity of colour harmony is reflected in the complexity of their descriptive model of colour combination. In addition, in relation to esthetic response in general and responses to colour in particular, Osgood et al. suggest that responses are multidimensional and involve cognitive and affective components. Osgood et al. further suggest that esthetic response is not fixed but may vary according to changing conditions. In relation to broader environment-behavior studies, Nasar suggests that esthetic response is a complex process involving affect, affective appraisal, cognitive judgements, perceptive influences as well as the individual characteristics, personality, affective state, and cultural experiences of the observer.

Finally, a range of factors are likely to exert an influence on responses to colour in general and esthetic response to colour in particular. For example, Manav indicates that individual characteristics such as age and gender play a role; and Svedmyr suggests that another individual characteristic, familiarity, may also exert an influence. Whereas Aslam’s cultural analysis of colour meanings as well as Whitfield and Wiltshire’s along with Janssens research indicates that both individual and cultural experiences may also be significant in terms of responses to colour. In addition, ambient lighting and time of day exert an influence on the perception of colour and it is highly likely that a larger range of perceptual and contextual effects influence esthetic response to colour to some degree. For example, Fridell Anter provides a convincing argument for the difference between inherent colour and perceived colour; while Goldstein describes simultaneous contrast and its influence on responses to colour (also discussed by Albers, Chevreul, Hård and Sivik, and Itten). In addition, perceptual effects such as the Craik-O’Brien effect and the Bezold effect (as described by Davey et al. and Kanizsa respectively) may also influence the interface between colour and esthetic response. In relation to context, Taft and Sivik advocate that context plays a role in terms of meaning and response to colour; and Smith has identified three states (viewer state, participant state, and immersed state) and suggests that these influence responses to colour in regard to the person-environment context whereby each state varies in terms of levels of engagement between observer/participant and contextual colour. Porter and Mikellides suggest that responses to colour are likely to change over time and may be dependent on changing social trends. However, Wise and Wise assert that humans are not hard-wired, psychologically or physiologically, to respond in any particular way in regard to colour; while Mehrabian suggests that an individual’s stimulus screening ability accounts for differences in sensitivities to stimuli.

To summarize, defining colour harmony is clearly problematical given all of the influences and factors, which may impinge on the relationship between colour and esthetic response. However, to move toward a revised definition of colour harmony, a discussion of the nature of colour harmony theories and also the key assumptions underlying these theories is appropriate.

**THE NATURE OF THEORIES RELATING TO COLOUR HARMONY**

Colour is a complex phenomenon and its complexity is revealed when we consider that colour is experienced across a variety of situations, settings, formats, and configurations. In an attempt to understand the ambiguity of colour, Green-Armytage has identified seven different variations relating to the concept of colour: conventional colour, substance colour, formula colour, spectral profile colour, psychophysical colour, inherent colour and perceived colour. In addition, humans can discern a huge range of unique colours, and while many variations and nuances of colour may be beyond the threshold of human vision, Hård and Sivik suggest that the number of possible colour combinations is “almost infinite” (p 4). However, the complexity of colour did not impede early attempts to describe and explain colour or define and predict colour harmony, and many such theories which are evolved in the fields of art, design, psychology, and physics.

The assumptions that underlie the various attempts to explain or predict colour harmony reflect diverse theoretical frameworks and paradigms. However, the notion of theory itself has a range of meanings. For example, Goodson and Morgan suggest that theory provides explanation via a set of statements that include definitions, assumptions, laws, hypotheses, and so on. While Lang proposes that theory is an attempt to describe, explain,
and predict an aspect of reality; and Moore advise that normative design theories are defined as a set of principles or linked axioms that are programmatic and suggest “an idea of how things ought to be done” (p 24). The range of colour harmony theories includes explanatory theories through predictive and programmatic theories.

In addition, colour harmony theories also tend to exhibit most of the “competing” paradigms that Guba and Lincoln suggested guide research and underpin theory: positivism, postpositivism, critical theory, and constructivism (p 105). Of these, all but critical theory are predominantly evident in colour harmony theories and it is the fundamental differences in the patterns of knowledge within each paradigm that has, to a certain extent, contributed to the ambiguity and lack of consensus in regard to colour harmony. Positivism, postpositivism, and constructivism were evolved from the earlier paradigms of rationalism and empiricism, and these are evident in the colour theories of Newton and Goethe. As noted by Gage, many subsequent colour harmony theories can be traced back to those of Newton and Goethe, and it is therefore appropriate to discuss the earlier paradigms of rationalism and determinism before proceeding.

Rationalism was underpinned by the notion that any aspect of reality can be established by nonempirical reasoning alone and Newton adopted an essentially rationalist approach to his theories of colour and colour harmony. A rationalist slant is also evident in the colour harmony theories and formulae of Ostwald, Munsell, and Moon and Spencer. However, rationalism has been superseded as a theoretical paradigm, and while the notions of the colour theorists mentioned earlier still enjoy a degree of recognition, the veracity of their theories is now highly questionable mainly due to the bias, lack of objectivity and evidence, and preponderance of unsubstantiated claims and assertions.

Goethe’s colour harmony theory was more empiricist than rationalist and underpinned by the notion that knowledge is received from nature via the senses, experience, and empirical investigation. Goethe’s empiricist approach is evident to a certain extent in the colour harmony theories of Munsell, Chevreul, and Itten. However, a key weakness of the empiricist approach was the tendency to adopt a confirmatory and therefore biased approach to empirical investigation that undermines the veracity and validity of findings.

Evolving from empiricism, positivism involved attempts to explain and predict the aspects of reality, and incorporated the doctrines of reductionism and determinism. Reductionism allowed early colour theorists to apply Ockham’s razor* in attempts to “fixity on the flux” in relation to the complex phenomenon of colour as evidenced by the formulation of simple, representational colour wheel models and one-size-fits-all rules and principles for colour harmony. In relation to attempts to explain or define colour harmony, the inherent weakness of reductionism is clear when considering the range of distinguishable colours as well as Hård and Sivik’s assertion that the number of possible colour combinations “is almost infinite” (p 4).

Determinism, another feature of positivist theories, suggests that the universe operates as an ongoing and complex sequence of cause and effect. A determinist approach, which exists in many colour harmony theories, suggests that a strong and irrefutable causal relationship exists between colour and esthetic response irrespective of other mediating factors or influences. However, as discussed below, recent studies indicate that a range of factors exert an influence on the interface between colour and positive esthetic response.

The inherent weaknesses of positivism as well as the doctrines of reductionism and determinism prompted the emergence of post-positivism in the mid 20th century. Guba and Lincoln suggest that these weaknesses had to do with the idea that any aspect of reality is both apprehendable and quantifiable, and can be studied in time and context-free isolation.

Under the postpositivist paradigm, Guba and Lincoln suggest that any aspect of reality can only be “imperfectly and probabilistically apprehendable” rather than explainable and predictable (p 109). Furthermore, Popper suggests that the stripping of contextual factors or influences through experimental control; the generalization of findings from one study to other situations, contexts or populations, and putting forward conjectures as explanation without any “ingenious or severe attempts to refute them” are unsound from a post-positivist perspective (Popper cited in Ackerman, p 109). The colour harmony theories of Albers as well as Hård and Sivik are basically postpositivist. For example, Albers asserted that colour combinations are always open to the influence of contextual as well as perceptual effects and he essentially rejected the notion of colour harmony as a universal phenomenon, suggesting that predictive approaches to colour are...

... worn out. No mechanical colour system is flexible enough to pre-calculate the manifold changing factors... in a single prescribed recipe (p 42).

The constructivist paradigm, as defined by Guba and Lincoln, suggests that reality exists in “the form of multiple, intangible mental constructions... often shared among individuals and even across cultures... constructions are not more or less true in any absolute sense” (p 110). While constructs in any particular area of research may achieve a level of consensus, Guba and Lincoln suggest that they are alterable and always open to review, revision, and reinterpretation. Since many of the early col-

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*Ockham’s razor, a doctrine attributed to William of Ockham, 13th century, suggests that where there are two explanations for the same phenomenon, the more complicated is likely to be erroneous in some way, and other things being equal, the simpler explanation is likely to be correct.

our harmony definitions appear fixed and inflexible, it is perhaps timely that the construct is reviewed and revised.

Finally, in reference to the emerging field of network theory as described by Strogatz and Newman, it is possible that patterns of esthetic response to colour may reflect the structure and operation of networks in terms of structural complexity and node diversity. That is, responses to colour may cluster to a range of different nodes depending on many factors that influence the interface between colour and esthetic response.

In summary, the lack of consensus and ambiguity in regard to the definitions of colour harmony are due in part to the inherent differences in theoretical paradigms and doctrines underpinning colour harmony theories. However, it is also the assumptions, embedded within definitions and theories of colour harmony that expose the weaknesses of these and provide additional impetus to update this construct.

KEY ASSUMPTIONS RELATING TO COLOUR HARMONY

A number of ontological assumptions are embedded within the diverse theoretical paradigms discussed earlier. Both Moore and Crotty advise that ontology has to do with the fundamental nature of the construct under focus as opposed to its theoretical framework. Furthermore, Moore suggests that ontological assumptions, which act like a lens through which a research topic is perceived, exist along continuums. These ontological assumptions are discussed as follows in relation to colour harmony:

(a) Nomothetic-idiographic: That is, whether colour harmony can be defined and explained in terms of universal laws, rules, or principles that apply to all; or whether such universal laws, rules, and principles are inappropriate due to the influence of individual differences (age, gender, cultural experience, personality, affective state, etc) as well as contextual, perceptual and temporal factors.

(b) Deterministic-random: That is, whether colour harmony can be defined as a strictly cause-effect phenomenon and that an irrefutable causal link exists between colour and esthetic response; or, whether colour harmony can be defined as a more stochastic and randomly determined phenomenon, and therefore less predictable and more probabilistic.

(c) Atomistic-holistic: That is, whether colour is essentially divisible (that is, can be broken down into discrete, isolated parts and studied as such) and that colour harmony can be defined as an isolatable phenomenon effectively existing in a vacuum; or, whether colour harmony is a more holistic phenomenon existing within a state of flux and therefore more than the sum of its parts.

These ontological assumptions are particularly significant in relation to colour harmony as they bring into focus the research bias inherent in attempts to define and predict colour harmony. These attempts can be categorized as follows.

COLOUR HARMONY: UNIVERSAL AND DETERMINISTIC

Under this ontological assumption, colour harmony is accorded the status of a universal and predictable phenomenon. This assumption is evident in the way as colour harmony treated by Newton, Goethe, Chevreul, Ostwald, Munsell, and Moon and Spencer; as well as in more recent studies (for example, see Ou and Luo, Nemcsics, as well as Hsiao et al.). This approach is often coupled with an atomistic understanding of colour harmony wherein studies focus on esthetic response to colour in a piecemeal manner and often in isolation as evidenced by the myriad of studies that use a limited range of coloured chips or singles/pairs of colours as visual stimuli.

This ontological approach to colour harmony has a number of weaknesses. First, it assumes that one-size-fits-all colour harmony formulae, rules or principles are appropriate despite studies indicating that a range of factors influence esthetic response to colour such as individual and cultural differences, and also contextual, perceptual and temporal factors. For example, an individual’s affective state (also referred to as core affect) is known to vary or change throughout the day and on a day-to-day basis. Furthermore, affective state is considered to influence the esthetic response and to extrapolate esthetic response to colour.

Second, while studies exist propose the existence of a causal link between colour and esthetic response, the results of these studies may be study-bound and the generalization of such findings to other settings, different contexts or varying population segments is now considered methodologically unsound as noted by Guba and Lincoln, Popper and Moore. In addition, studies evaluating esthetic response to colour in controlled environments or in time or context-free isolation tends to lack reliability and transferability as advised by Guba and Lincoln. These weaknesses suggest that defining colour harmony as a universal and deterministic phenomenon renders the construct outdated from a current theoretical perspective.

COLOUR HARMONY: IDIOGRAPHIC AND CONTINGENT

Representing a revised and updated understanding of colour harmony, this approach is underpinned by the ontological assumption that colour harmony is open to a range of influences and can therefore only be probabilistically described, defined or predicted. Under this approach, colour harmony can be defined as the phenomenon that occurs when colours seen together elicit a positive esthetic response. However, esthetic response is considered contingent on the characteristics of the observer (age, gender, cultural experiences, personality, and underlying but pervasive affective state) and also on the influence of perceptual, contextual, and temporal factors.

A conceptual model of this revised definition of colour harmony has been developed, the theoretical basis of which has been discussed previously (see O’Connor).
Representing a focused and more specific version of Lewin’s conceptualization of the human-environment interface amalgamated with Nasar’s probabilistic model of esthetic response, the colour harmony conceptual model is as follows.

Colour harmony

\[
    f(Col_1, Col_2, \ldots) \times (ID + CE + CX + P + T)
\]

Wherein colour harmony is a function \(f\) of the interaction between colour \(\text{Col}_1, \text{Col}_2, \ldots\) and the factors that influence positive esthetic response to colour: individual differences \(ID\) such as age, gender, personality, and affective state; cultural experiences \(CE\), the prevailing context \(CX\) which includes setting and ambient lighting; intervening perceptual effects \(P\) and the effects of time \(T\) such as social or design trends that change over time.

In line with current theoretical paradigms, the conceptual model is essentially probabilistic rather than predictive; plus it is idiographic rather than universal and deterministic thereby allowing for esthetic response to colour to vary in line with changes in age, gender, personality, and cultural experience. In addition, the conceptual model does not assume that esthetic response to colour remains static irrespective of context or mediating perceptual effects. Furthermore, the conceptual model can accommodate changes in social trends and design styles over time which may impact on the relationship between colour and esthetic response. Finally, by allowing for the various influences that impact on esthetic response to colour, the conceptual model allows for, but does not assume, consistency of esthetic response to colour irrespective of the manifestation of colour (substance colour, formula colour, spectral profile colour, and so on) or the physical embodiment of colour (object or artefact).

**CONCLUSIONS**

In reviewing colour harmony as a construct, this article noted the ambiguity and lack of consensus regarding colour harmony in the literature. The disparate assumptions and diverse theoretical paradigms embedded within a range of colour harmony theories were examined revealing the weaknesses underlying these. In addition, it was noted that many of the theoretical paradigms underpinning extant colour harmony theories (such as rationalism, empiricism, and positivism) have been superseded by postpositivism and constructivism. As a result, it was acknowledged that colour harmony as a construct requires some revision in line with current theoretical paradigms. In response to this, a revised definition of colour harmony is provided along with a conceptual model that acts as a conceptualization of this updated definition. This conceptual model is probabilistic rather than predictive and defines colour harmony as positive esthetic response to colour contingent on a range of factors that include the individual characteristics of the observer (age, gender, personality, and affective state), the cultural experiences of the observer, and also the influence of perceptual, contextual and temporal factors.