Traditional colour theory in design context: A focus on value

Zena O'Connor

Design Research Associates, Sydney; The Colour Collective, Sydney
Email: zena@zenaoconnor.com.au

Traditional colour theory, a branch of colour theory that is relevant for architects and design professionals, is characterised by conceptual colour models and constructs which occur in the literature on colour, design education, and professional practice. While the origins of traditional colour theory date back centuries, it is a branch of colour theory that has attracted criticism, which tends to focus on hue-based colour models and constructs, and a lack of correspondence with colour science. Despite this, many constructs that abound in traditional colour theory have come to represent colour strategies commonly used across applied design and design of the built environment. While hue-based constructs and colour strategies are common in traditional colour theory, design education, and design practice, this paper focuses on value-based constructs and related colour strategies for two key reasons. Firstly, to corral information about value-based constructs and colour strategies. Secondly, to highlight the important role that value-based contrasts and colour strategies play in achieving specific aims relating to legibility, differentiation, perceptions about ambience and atmosphere, and environmental visual literacy. Value-based constructs are explored via a survey of traditional colour theories using archival and desk research. Outcomes summarise and discuss the role of value in design praxis.

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Defining value

Value is an attribute of colour and variations in value have been a feature of art for centuries. Within this context, variations of lightness and darkness plus specifically allocated light-dark contrast (chiaroscuro) were techniques used to great effect by artists including Leonardo Da Vinci and Caravaggio to attract attention, create focus, a sense of depth, and atmosphere. An example is Caravaggio's The Calling of St Matthew (1599-1600) which features strong light-dark contrast to highlight key figures and create a sense of drama in the painting [1-2].

In the literature on colour, the attribute of value within the context of traditional colour theory is generally considered to refer to variations of lightness and darkness within both achromatic and chromatic colour. Many theorists provide diagrams, illustrations, and grey scales to describe variations of value. Grey scales represent clusters of grey samples in a stepped format from white through to black. These diagrams, illustrations and scales are limited in terms of pictorial representation of value and tend to represent conceptual, generalised representations [1-3].

In the literature on colour, the attribute of value is also referred to as tone and tonal value. In praxis and texts relating to applied design and design of the built environment, tonal value is often used in discussions when multiple tonal variations of value are evident. For the purposes of this paper, tonal value and value are used rather than tone. The former is used in discussions relating to variations of value and the latter to the attribute in a general sense

Context and key aims

Traditional colour theory is one branch of colour theory and within this context, colour is considered to have three key attributes: hue, saturation, and value. The attributes of colour are often discussed in relation to conceptual colour constructs and models as well as colour charts and illustrations commonly found in traditional colour theory [1,3]. This branch of colour theory achieved a degree of prominence in design praxis and design education in tandem with the emergence and establishment of design as a profession [3-4].

Prior to the Industrial Revolution period in the West, design-related activities remained within the context of small-scale, home-based craft industries. As mass-production emerged and increased, design was often characterised by randomly adopted elements of several design styles plus the outright copying of design and colour from pattern books such as those by Owen Jones (Grammar of Ornament, 1868) and Christopher Dresser (The Art of Decorative Design, 1862). As cottage industries declined, the rise in mass manufacturing for a vastly increased consumer base prompted the emergence and prominence of the role of designer across the applied arts and design of the built environment; however, the relative absence of design standards at this time came to be considered problematic [4-6]. For example, Loos advocated against the random copying and application of design motifs in architecture, furniture, objects d'arts, textiles and interior design, and he decried excessive and unnecessary ornamentation [7]. In response to issues relating to the lack of standards for design and quality, design reform became inevitable, and this occurred virtually in tandem across industry, manufacturing, and design education [3-4].

From the mid-nineteenth century through to the emergence of digital design technologies, design professionals and architects often presented design proposals and illustrations using gouache paint, a medium commonly used within the context of traditional colour theory [3]. As the nineteenth century progressed, the ever-increasing emergence of new pigments provided a greater range of accessible pigment colours thereby solving the problem of unstable intermixture. The first collapsible metal paint tube (initially patented in 1841 by American John Rand) was perfected with a screw cap by English paint manufacturers Winsor and Newton in 1842 and this considerably enhanced the accessibility and application of pigment colour across the arts and design professions [8-9].

From the late nineteenth century though to the twentieth century, both traditional colour theory and the way in which colour theory was taught within the context of design education evolved and changed in response to changes in industry, manufacturing, and printing technologies plus evolving ideas about design education. While the ontological focus remained the same, epistemological traditions changed.

That is, the aesthetico-mathematical, deterministic, and rigid ideas and formulae of colour theorists like Ostwald and Munsell were superseded by a less deterministic approach characterised by practical guidelines intended for inspiration and exploration, plus a stronger focus on individual creativity and an informed intuitive approach to the use of colour, as per the colour design theories of Dow, Ross, and Parsons through to Albers and Itten [10-20].

Today, traditional colour theory relates to four key areas of colour specialty: Colour industries, technologies, and applications; Colour (re)production; Colour humanities; and Colour aesthetics, as per Morovič's preliminary taxonomy study of colour specialities [21]. Morovič's study identified eleven top-level areas of colour speciality as well as multiple areas of colour sub-speciality, see Figure 1.

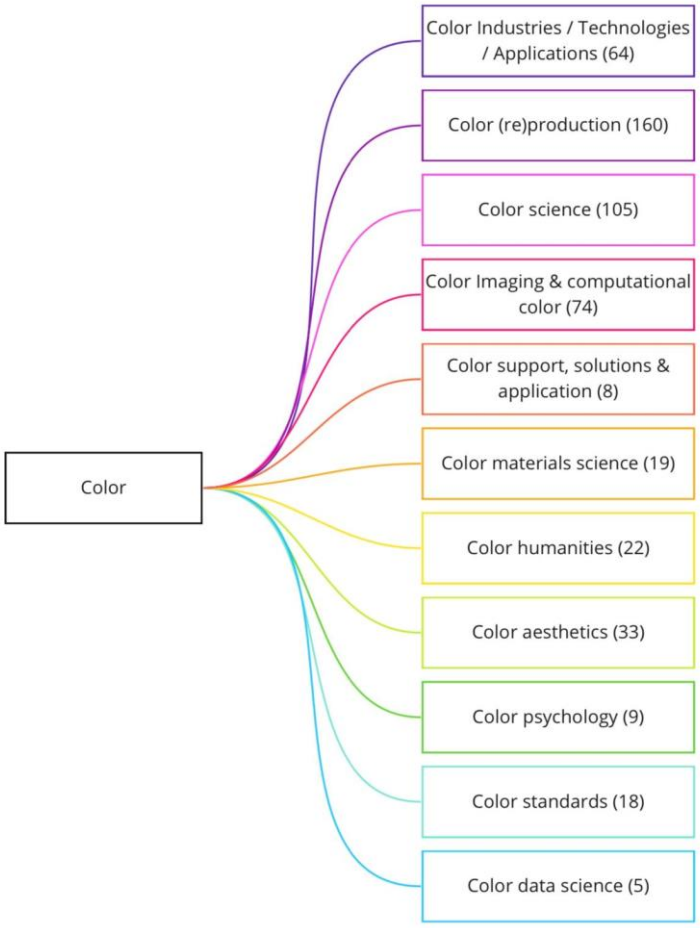

Figure 1: Eleven top-level colour specialty areas with related areas of sub-specialty indicated by numbers in brackets. Traditional colour theory relates to four key areas of colour specialty: Colour industries, technologies, and applications; Colour (re)production; Colour humanities; and Colour aesthetics [21].

In contemporary design praxis and design education, colour constructs drawn from traditional colour theory abound and have segued into colour strategies, as discussed in greater detail below [1-3]. While traditional colour theory has attracted criticism, O'Connor notes that much of this criticism revolves around hue-related constructs such as primary colour as well as hue-based conceptual colour models plus the lack of correlation with colour science [20]. Criticism of traditional colour theory rarely discusses the attribute of value and value-related constructs and conceptual models and illustrations.

The aims of this paper are to initially corral and discuss value-related constructs and draw attention to the role that tonal value contrast and value-related colour strategies play in achieving specific aims. In applied design and design of the built environment, these aims generally relate to legibility,

differentiation, perceptions about ambience and atmosphere, and environmental visual literacy. A survey of traditional colour theories provided the basis to summarise, discuss, and illustrate value within this context.

Methodology

A survey of colour theories relating to the attribute of tonal value was conducted to explore and identify ideas about tonal value and constructs related to this attribute. As a plethora of colour theories occurs in the literature on colour, the survey focused on accessible key sources primarily within the context of traditional colour theory – specifically those that discussed value. In addition, texts that featured diagrams, charts or illustrations relating to value were included in the survey. As such, the survey was limited and does not present an exhaustive survey.

For this survey, archival and desk research involved accessing the literature on colour plus databases and archives of relevant sources. These sources included the Getty Research Institute, the Bauhaus Archive, and the online archives of organisations, design schools, and universities as noted in the reference list.

Exploring constructs related to value

The survey of traditional colour theories indicates the occurrence of multiple conceptual colour constructs which tend to fall into one of three different categories, as below. Value is not a stand-alone attribute but is an inherent quality of any colour and is therefore relevant to each of these categories.

- Hierarchical colour constructs refer to classifications of colour hierarchy and include primary colour, secondary colour and tertiary colour. These constructs are often illustrated via conceptual colour models, diagrams, and colour charts.
- Colour constructs relating to colour relationships and colour groupings based on distinct patterns of similarity and difference. These constructs include analogous colour, complementary colour, monotone, monochromatic colour, keys, and chords. This second category of colour construct is generally defined within the literature and accompanied by text-based diagrams, colour models, colour charts and illustrations.
- Exploratory colour constructs include broken colour, colour discord and vibrating colour. These are defined in the literature, but variations occur depending on application and context, and therefore require exploration and experimentation.

In the past, discussions about tonal value often referred to constructs such as *chiaroscuro* and *grisaille* plus terms borrowed from music theory: *scales*, *chords*, and *keys*. In this context, *chiaroscuro* and *grisaille* as well as *brunaille*, *verdaille*, and *unione* refer to specific variations of tonal value generally employed in painting to create focus and convey a sense of mood and atmosphere within painting.

The terms *scales*, *chords*, and *keys* emerged in traditional colour theory primarily due to an invented analogy between colour and music, as discussed by several theorists including Field and Hayter (see below). In reference to tonal value, *scales* represent a sequence of greys along a continuum from black and dark values through to lighter values and white. *Chords* represent clusters of tonal values that

feature similarity (*minor chord*) of tonal value or difference (*major chord*). *Key* or *key-note* refers to a dominant tonal value within a cluster of tonal values. In this context, high key relates to lighter tonal values, intermediate key to mid-scale tonal values, and low key to darker tonal values.

Early colour theorists often used text-based diagrams, and black-and-white illustrations to demonstrate variations of tonal value (as per illustrations by Rood and Ross in Figures 2 and 3). Primarily due to developments in full-colour printing, subsequent theorists used coloured scales, charts, and illustrations that featured geometric shapes including circles, semi-circles, and squares to indicate variations of tonal value and related constructs.

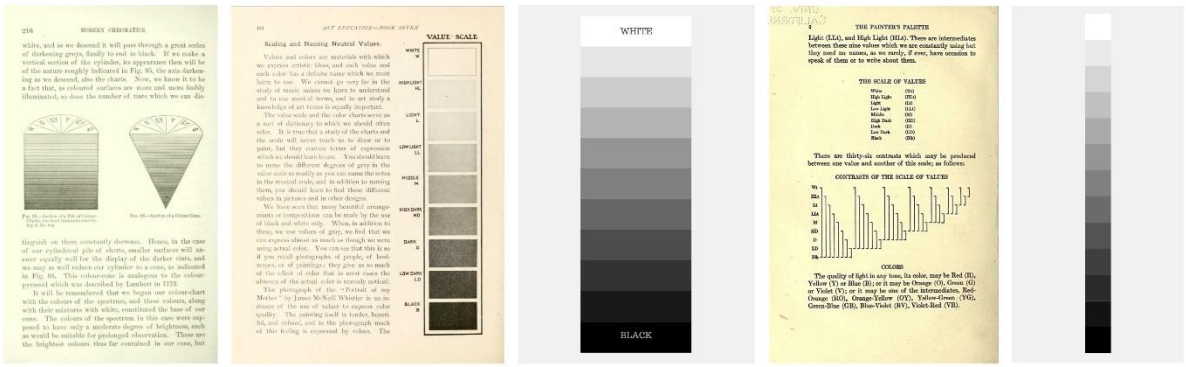

Figure 2: From left to right – Scales and the 'natural order of colour': Rood (1879), Ross as depicted by Froehlich & Snow (1904), Munsell (1919), Ross (1919) and Itten (1961).

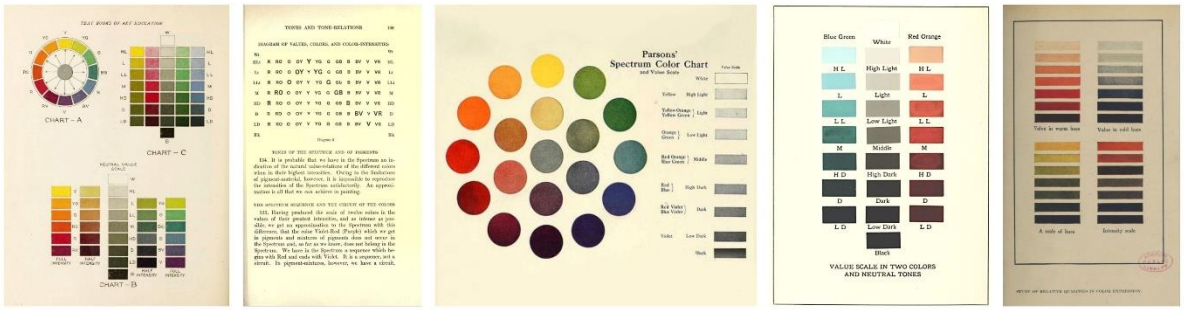

Figure 3: From left to right – Tonal value charts with hue equivalents from Froehlich & Snow (1904), Ross (1907), Parsons (1912), Snow & Froehlich (1918) and Parsons (1921).

While scales, charts, and illustrations were used to augment and demonstrate text-based information by early theorists, subsequent colour design theorists and educators like Froehlich and Snow as well as Parsons provided diagrams and illustrations that were intended as opportunities to experience, explore, and identify tonal value nuances and constructs (such as those featured in Figure 3). Later theorists and especially those concerned with integrated colour design, also included discussions about the likely impact and application of tonal value nuances and contrasts.

Constructs that focus on tonal value (such as keys, chords, and scales) are often discussed in recent texts in relation to the ways these may be employed in applied design and design of the built environment. Tonal value contrast is often used by designers as a device to attract attention and create focus and differentiation. The capacity of tonal value contrast to be harnessed in this way is primarily due to the mechanics of human vision which is essentially hard-wired to notice and focus on strong variations in contrast [22-23]. In addition, various clusters of tonal values are considered to have the

capacity to convey a sense of mood, atmosphere and ambience in applied design and design of the built environment [2-3].

Exploring theories about tonal value

Two of the earliest monographs that featured illustrations depicting nuances of tonal value include the Mayerne Manuscript and A. Boogert [24-25]. The Mayerne Manuscript (1620-1646) features three pages of tonal value nuances depicted in pigments such as viridian and cinnabar. Boogert's (1692) monograph represented a precursor of colour identification systems like Pantone, and featured 800+ handwritten and hand-painted pages, illustrating variations of hue, tonal value and chroma, as per Figure 2. Little is known about the author, who did not provide specific information about tonal value but featured multiple variations in the book [26].

More than a century later, French illustrator and engraver Gaspard Grégoire (1751-1846) devised a mathematically calculated colour order system using three attributes: hue (*teinte*), saturation (*ton*) and variations of lightness/darkness (*nuance*) [27]. In respect to variations of lightness and darkness, Grégoire developed some of the earliest tonal value charts and a seven-step grey scale, featured in Figure 4. Grégoire also discussed an analogy between colour and music, and used music-related terms to reflect colour clusters [27-28].

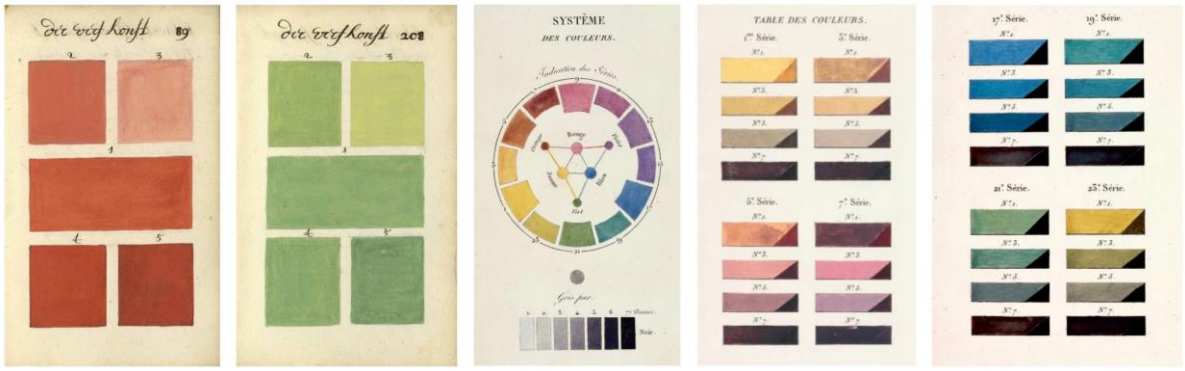

Figure 4: Illustrations from Boogert (1692) at left and Grégoire (1820) at right illustrating variations of tonal value.

Charles Hayter, George Field, David Ramsay Hay: Chords, keys, and scales

While analogies between colour and music date back centuries, references to chords, keys, and scales specifically in relation to tonal values came to the fore in the early nineteenth century. In this context, these constructs referred to clusters of achromatic or chromatic colours that feature patterns of similarity or difference in respect to nuances of tonal value.

English painter Charles Hayter (1761-1835) devised The Painters Compass, aimed at guiding colour application in art. Based on the RYB colour model, Hayter's illustrations featured variations of tonal value in conjunction with hues, with both attributes grouped into clusters [29, p.23]. Hayter refers to an analogy between music and colour and cautions that, just as scales do not represent music, so too colour scales do not represent the complexity of colour representation, "*in as much as a gamut is not any distinct tune of itself, so a chromatic scale of colours is not any distinguishable picture*" [29, p.13].

Similarly, English chemist and artists' colourman, George Field (1777 -1854), who had an association with pigment paint manufacturers Winsor & Newton, used music terminology in *Chromatics* and discusses the notion of an *archeus* or key colour [30, p.18]. This key colour represents a predominating colour tone to which others in a cluster are subordinate. Field presented one of the earliest illustrations to demonstrate the analogy between music scales and clusters of similar hues and tonal values in *Chromatics* [30, p.33]. In reference to this illustration, featured in Figure 5, Field refers to a Chromatic scale comprised of notes or keys: A, B and C, representing darker tonal values, mid tonal values, and lighter tonal values. Field also refers to the notions of concord and discord in reference to the allocation of tonal values within this illustration [30, p.33; 31, p.79].

Field's ideas about keys and chords influenced theorists who came after him. Raz notes that Scottish artist and interior decorator David Ramsay Hay (1798-1866) was one of the first to discuss in greater depth the constructs of keys and chords in relation to clusters of similar hues and tonal values in *The Laws of Harmonious Colouring* [32]. Hay suggests that "*Each of these colours is capable of forming an archeus or key for an arrangement, to which all the other colours introduced must refer subordinately. This reference and subordination to one particular colour, as is the case in regard to the key-note in musical composition, gives a character to the whole*" [33, p.18]. That is, a key hue or tonal value represents a predominant characteristic within a cluster of colours. Hay also allocated lighter tonal values to higher notes on the music scale, as per his illustration in Figure 5.

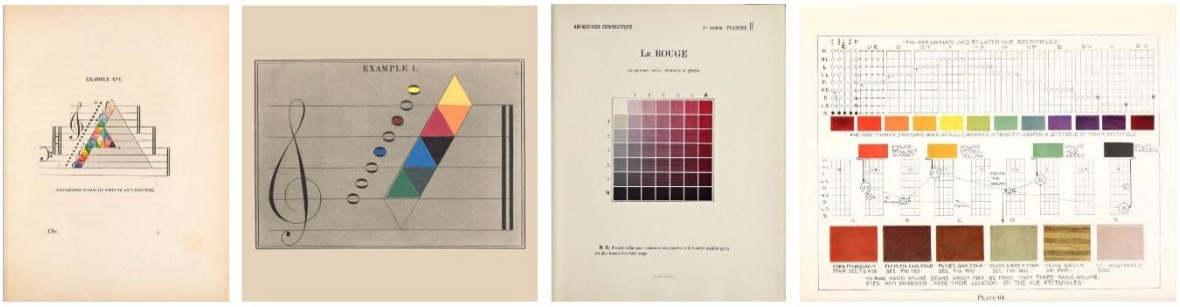

Figure 5: Illustrations from Field (1817), Hay (1838), Lacouture (1890) and Varnum (1916) which feature overt or discreet references to the analogy between colour and music.

Ogden Rood (1831-1902) referred to variations of tonal value throughout '*Modern Chromatics*' (1879) and presented black and white colour charts that depicted twelve hues in layers of tonal value variations, with the lighter, "most luminous" values at the top down to darker tonal values at the bottom. Rood notes, "This colour-cone is analogous to the colour- pyramid which was described by Lambert in 1772" [34, p.216]. Rood discussed the ways in which darker tones tend to visually retreat and lighter tones to visually advance, and referred to a series of 'sunset hues' which he also described as a 'normal series' of hues which featured a descending scale of hues from lighter hues (yellow and orange) through mid-toned hues such as red, down to darker hues, purple, violet-blue and grey-blue. Subsequent authors (such as Carpenter, 1915) understood this descending scale from lighter tonal values down to darker tonal values to represent a 'natural order' of tonal values.

French botanist Charles Lacouture (1832-1908), who aimed to establish a nomenclature of colour based on his observations, also used terminology related to music such as *diapason* (tuning fork, which represents a particular key-note in music) to describe clusters of hue and tonal value. In *Répertoire chromatique* (1890), Lacouture includes an illustration, *Rose Synoptique*, which features twelve colours (based on the RYB colour model) plus three lighter tonal variations and three darker tonal variations of

each colour. In addition, Lacouture features multiple seven-by-seven grids of each of the twelve colours, which are depicted in tonal variations from lighter values to darker values and uses the term *diapason* to refer to the various keys of these colour clusters, illustrated in Figure 5 [26, 35].

The use of constructs such as keys, chords, and scales became common in the literature on colour. Many colour theorists in addition to those mentioned above adopted these constructs and created charts and diagrams to illustrate and describe variations of tonal value clusters based on key, chords, and scales including Church (1870, 1872), Maycock (1895), Luckiesh (1915, 1918), and Varnum (1916), the latter of whom plotted hues and tonal values in a text-based and coloured scale as illustrated in Figure 5 [36-40]. Given the prevalence of value-related constructs in the literature on colour, they inevitably appeared in teaching materials in art and design education.

Tonal value scales and a 'natural order of colour'

The concept of a 'natural order of colour' related to the notion of allocating tonal values in a sequence along a continuum, which was often depicted in vertical order with lighter values at the top down to darker values at the base. Considered to reflect the tonal value order found in nature, colour theorists applied this vertical order to illustrations that featured a sequence of hues and tonal values together [21].

Many tonal value illustrations from Boogert onwards feature this vertical arrangement of values. Figure 2 includes scales from Rood (1879), Froehlich & Snow sourced from Ross (1904), Munsell (1919), Ross (1919) and Itten (1961), and each of these features lighter tones at the top gradating down to darker tones. In the twentieth century, nine-step tonal value scales featured in colour education across multiple design schools worldwide including the Parsons School of Design (New York) and the Shillito Design School (Sydney). Within this context, an odd-numbered scale was often recommended as it provided the student with the opportunity to visually identify and create mid-grey as well as lighter and darker tonal values using gouache paint or a similar medium.

Field referred to concord and discord within the context of a sequential order of tonal values. Concord was aligned with notions about colour harmony and discords with negative response to colour clusters. In respect to the discord, Abbott defined them as "generally unpleasant and cause irritation…they are produced by deviating from the standards of nature" [30, p.32; 41, p.109].

Ostwald and Munsell: The limitations of a prescriptive approach

Wilhelm Ostwald (1853-1942) and Albert Henry Munsell (1858-1918) were both concerned with developing colour notation systems for practical application in art and design, and their theories were underpinned by aesthetico-mathematical imperatives. Both Ostwald and Munsell discussed tonal value and applied a deterministic approach to colour identification and application. Ostwald asserted that "(colour) harmony is order" and his approach to colour involved prescriptive colour guidelines [8, 26]. Similarly, Munsell's colour system was underpinned by the decimal system, and he advocated various prescriptive rules for colour design composition including "use a high value with a low value" [9-10].

Both Ostwald and Munsell presented tonal value scales. Ostwald's featured a fifteen-step scale reduced to an eight-step scale, and Munsell's featured eleven positions that started with black (0) through ten steps to white (10). Munsell's colour charts such as those featured in Figure 6 provided useful information in respect to understanding the inherent tonal value of colours with the context of

colour education and colour application. Ostwald coined the term 'shadow' colours to represent hues with relatively high proportion of intermixed grey [42]. These 'shadow' nuances came to be referred to as *shadow palettes*, a colour strategy frequently used in applied design.

The prescriptive nature of Ostwald's and Munsell's theories about colour application proved to be a limitation. That is, industry and manufacturing requirements were constantly evolving in response to market needs and demands, and this required colour design solutions that also had the capacity to evolve. In addition, colour design education was also evolving and allowing for greater freedom of individual artistic expression in applied design and architectural design.

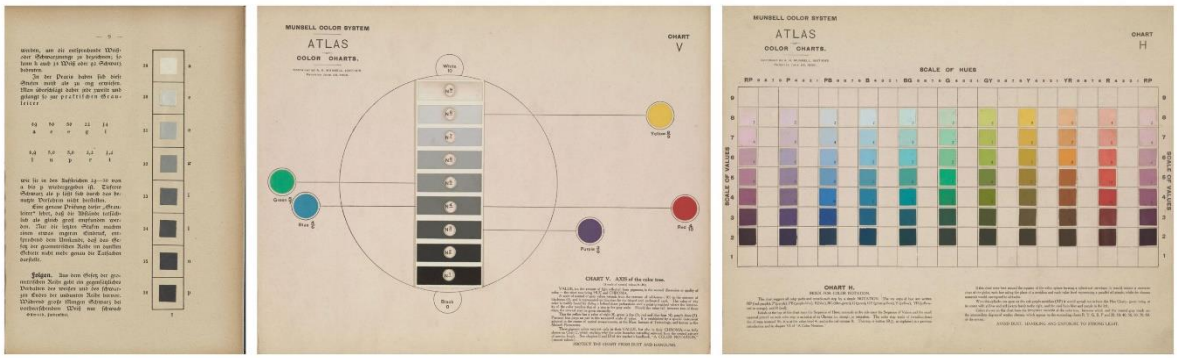

Figure 6: A tonal value scale from Ostwald (1921) far left and Munsell's (1915) tonal value scale with hue equivalents (middle and right).

Ross, Dow, and Parsons: An integrated approach to applied colour design

As design education evolved during the early twentieth century, the three most influential colour design theorists in education were Denman Waldo Ross (1853-1935) and his friend, Arthur Wesley Dow (1857-1922), and Dow's protégé Frank Alvah Parsons (1866-1930) [43-45]. All three developed integrated colour and design theories which they incorporated into their teaching at leading educational institutions. Specifically, colour theory was not taught in a vacuum but rather in conjunction with design application, with imperatives related to applied design as well as design of the built environment [1, 3, 46].

American painter and scholar of art history and theory, Denman Waldo Ross (1853–1935) was professor of design at Harvard University from 1889 until 1935. In *A Theory of Pure Design*, Ross follows precedent set by earlier theorists and incorporates terminology drawn from music to discuss colour nuances and colour relationships: *As in Music we pass from one key to another, modulating through notes and chords which are common to both keys; so in Painting, it is possible to modulate from one palette to another, from one tonality to another, making the transition through tones and mixtures which are common to both palettes* [15, p.65].

Specifically in respect to tonal value, Ross advocated exploration and experimentation, and he suggested that "*the study of tones and tone-relationships means the study of pigment materials and their effects…we cannot know much about tone and tone-relationships until we have had experience in the use of pigment materials. We must be able to distinguish tones, however slight the differences of value or of color or color intensity, and we must be able to produce tones according to our discriminations*" [15, p.133].

Ross devised a 'scale of values' that featured nine tonal values from *High Light* through *Medium* to *Low Dark*, which featured in his teaching syllabus (see Froehlich and Snow, 1904) [15, p.134]. To

illustrate what Ross referred to as 'Sequences of Values and Colors', he used a text-based diagram to demonstrate variations and nuances of tonal value and related hues, and this [15, p.137] and this diagram was presented in colour by two of Ross' students Froehlich and Snow (1904), who borrowed with acknowledgement to Ross his ideas related to colour and tone relations, chords and keys [47]. Ross' 1907 text featured detailed text-based diagrams rather than coloured illustrations and these diagrams predate Munsell's 'Scale of Hues' chart (1915) and Itten's chromatic light-dark contrasts chart (1961), which both illustrate the same concept. Ross' text-based diagrams, such as those featured Figures 2 and 3, represent detailed and highly practical information about colour and tonal value correspondences as per Munsell and Itten's charts. As such, Ross' diagrams represent a forerunner to Munsell's charts and pre-empt these by nearly a decade.

Dow and his protégé Parsons were amongst the most prominent teachers of design and composition for the applied arts in the United States. Dow taught at the Pratt Institute which was established in 1887 and was one of the first schools that focused on training for applied design [46]. Dow published '*Composition: A Series of Exercises in Art Structure for the Use of Students and Teachers*' (1899, 1903) and later taught at Columbia University. Dow was one of the first educators who aimed to liberate student artistic 'Power', his term for self-expression, at a time when many of his contemporaries still relied on the academic tradition of copying the masters [48]. In '*Composition*', Dow aimed to provide a colour and design language toolbox intended as a form of visual grammar that students could adopt and modify as required for their projects [49]. Composition was reprinted more than 20 times and used in design schools well into the 1970s [48].

In respect to tonal value, Dow introduced the notion of Notan, a Japanese concept relating to light/shade that was influenced by his interest in Japanese woodblock prints. Dow provided multiple ways in which variations of light and dark tonal values could be employed to attract attention, create focus and a sense of atmosphere within a composition or design.

Frank Alvah Parsons (1866-1930) was taught by Dow and began teaching at the New York School of Art (later renamed the Parsons School of Design in his honour) in 1905. In 1921, Parsons established the Paris Ateliers, now called Parsons Paris, the first American art and design school in Paris [45]. Of the many innovations that Parsons introduced at the New York School were courses in applied design including interior design, graphic design and commercial illustration, and fashion design. Both the Parsons School of Design and Parsons Paris continue to offer courses in undergraduate and postgraduate design. A highly influential design educator, Parsons published multiple texts relevant to applied design and his theories of integrated colour design are discussed at length by Snow and Froehlich [50].

In respect to tonal value, Parsons championed the importance and relevance of this attribute in applied design. While his colour and tonal value charts were reductionist in nature, Parsons' approach to tonal value indicated that he was not only cognisant of the subtleties of tonal value, but he understood its capacity to attract attention, create focus and convey a sense of atmosphere and ambience relative to aesthetic and communication objectives in applied design. Figure 3 features one of Parsons' hue and tonal value charts, reproduced by Snow and Froehlich (1918); Ross' (1907) text-based tonal value chart and tonal value charts from Parsons. (1912, 1921) [17, 19-20, 50].

Ross, Dow, and Parsons are significant due to their focus on teaching integrated colour design and their emphasis on using tonal value variations plus hue and chroma for strategic purposes in applied design. They also encouraged students to experiment with colour and explore their individual creativity and intuitive understanding within applied colour design. In this respect, their approach to colour design education foreshadowed the epistemological imperatives and curriculum of the Bauhaus.

Itten, Albers, and the Bauhaus: An industry focus on multiple design solutions

The Bauhaus (1919-1933) was an influential design school in Germany that provided an integrated colour design curriculum which evolved over time in response to changing manufacturing needs [51]. Among key teachers at the Bauhaus, Johannes Itten (1888-1967) was responsible for developing the foundational year course which included a colour component and Josef Albers (1888-1976), who was initially enrolled as a student, began teaching at the Bauhaus in 1922 [52].

Both Itten and Albers shared a similar approach to tonal value and considered this colour attribute to be a "most expressive and important" element in composition and applied design [16, p.16]. Both theorists also focused on the subjective impact of tonal value, variations in perception of tonal value (as well as hue and chroma) depending on context, and the way tonal value contributes to differentiation. Their texts feature numerous exercises, which represented opportunities for students to fully explore and experience the impact of colour and tonal value nuances.

After the Bauhaus closed in 1933, Itten taught at Zurich University of the Arts (1938-1954) and developed colour courses for the Ulm School of Design (1955). He published *The Art of Color: The Subjective Experience and Objective Rationale of Color* (1961) and this provided multiple ways in which to explore the nuances of colour and tonal value, and identify colour relationships including seven types of colour contrast. Albers emigrated to America in 1933, becoming head of Black Mountain College and subsequently head of design at Yale University in 1950. In 1963, he published *Interaction of Color*, wherein he extolled the virtues of experimenting with and exploring nuances of colour [13].

In reference to tonal value, Itten suggested, "*There is only one maximal black and one maximal white, but an indefinitely large number of light and dark grays, forming a continuous scale between white and black.*" [15, p.46]. To encourage students to explore the nuances of tonal value, Itten devised a series of exercises including a tonal value scale featuring thirteen variations between white and black. In respect to creating tonal value scales, Itten advised, "*The gray of medium brilliance should be in the center of the scale. Each individual step should be perfectly uniform and spotless, with neither a light nor a dark line between it and its neighbors*" [15, p.46].

Both Itten and Albers encouraged exploration of colour attributes and especially tonal value, plus the discovery of the ways in which colour and tonal value contribute to the expression of multiple design solutions. In addition, Bauhaus educators Herbert Bayer and László Moholy-Nagy advocated "absolute clarity" in respect to typography and this imperative for clarity in design came to underpin design outcomes at the Bauhaus in tandem with artistic expression [53-54].

Tonal value and related colour strategies in contemporary design

As the design profession evolved during the latter part of the twentieth century, the imperatives of design purpose and intention as well as clarity of design came to underpin the ways in which the elements and principles of design as well as the attributes of colour were used in applied design and design of the built environment [2-3].

In this context, objectives relating to clarity and legibility, environmental visual literacy as well intentional focus and differentiation came to the fore and design professionals harnessed the mechanics of human visual perception to help them achieve their design objectives. Specifically, the human visual perception system is hard-wired to notice colour contrasts in general and specifically, contrasts in tonal

value in terms of environmental perception and the perception of visual imagery and visual communications design [22-23, 55-57]. Design professionals adjusted colour contrast within design details such as headlines, brand names, logos, and product features in such a way as to ensure that design and communication objectives were met [58]. In this respect, Csillag notes that, due to the mechanics of human visual perception, Itten's seven types of contrast play an important role in effective visual communications design [59].

In design of the built environment, tonal value contrast and variations of lightness and darkness are allocated to achieve specific objectives. Specifically, colour and tonal values are intrinsically linked to the perception and understanding of a building's form and structure, and as a result, are allocated in a way to support this beyond considerations about aesthetics and decoration [60]. In addition, tonal value variations and strong colour contrasts enhance environmental visual literacy; that is, ensuring that the built environment can be easily 'read' and understood in a meaningful way by all users irrespective of visual capacity [61]. Effective environmental visual literacy is particularly important in the design of heath care, aged care, and dementia care environments [62-63]. Furthermore, effective colour as well as tonal value contrasts also play a key role in supporting orientation and wayfinding strategies in urban design and the built environment.

In contemporary applied design, various constructs associated with tonal value, including keys and chords, monotone, monochromatic colours, shadow palettes and the 'natural order of colour', have come to represent colour strategies. These colour strategies are now a common element across multiple areas of applied design and design of the built environment including interior design, graphic design, and visual communications design.

Tonal value colour clusters that depict variations of keys and chords are used to convey meaning and connotation across multiple design contexts. As per Froehlich and Snow, Ross was amongst the first to feature chords and keys in design education and discuss their use and impact in applied design at the turn of the century. Ross suggested that value keys – high, intermediate, and low – conveyed different impressions which translated into ambience and atmosphere depending upon the design application. For example, clusters of tonal values categorised as high key minor chords tend to convey a sense of *lightness*, *delicacy*, *freshness*, *crispness*, and *hygiene* depending on context; while clusters of tonal values categorised as low-key minor chords convey a sense of *mystery*, *drama*, and *moodiness* [18-19, 50].

Common colour strategies based on tonal value-related constructs abound in texts related to applied design, design for the built environment and design education [64-67]. In addition, as a design professional involved in colour within the context of applied design and the built environment for the last forty years, the author can attest to the widespread use of these strategies across professional practice in Australia. Specific colour strategies that often occur include monochromatic colour, defined as one hue presented in multiple different tonal variations; and monotone, defined as multiple hues presented in one tonal value. In addition, shadow palettes, which feature greyed colours, are often used in applied design including interior design and textile design. Similarly, the 'natural order of colour' is frequently applied in interior design to guide the allocation of colour nuances from lighter tones at the ceiling and cornices, down to darker tones at floor level. The following figure features book cover designs that illustrate a selection of these colour strategies. 'The urbanism of Frank Lloyd Wright' features a high key, minor chord cluster of tonal values. The book cover design of Albers' 'Interaction of Color' features an essentially monochromatic illustration in tonal value variations of red. The book cover designs of Zaha Hadid and Tadao Ando not only reflect the ways in which both architects use variations of tonal value in architectural design but also feature specific keys and chords: high key, major chord tonal values (Zaha Hadid) and intermediate key, major chord tonal values (Tadao Ando). Similarly, the

book cover design of 'Industrial Design: Reflections of a Century' features a major chord of tonal values in tandem with a monochromatic colour scheme based on tonal variations of sepia browns.

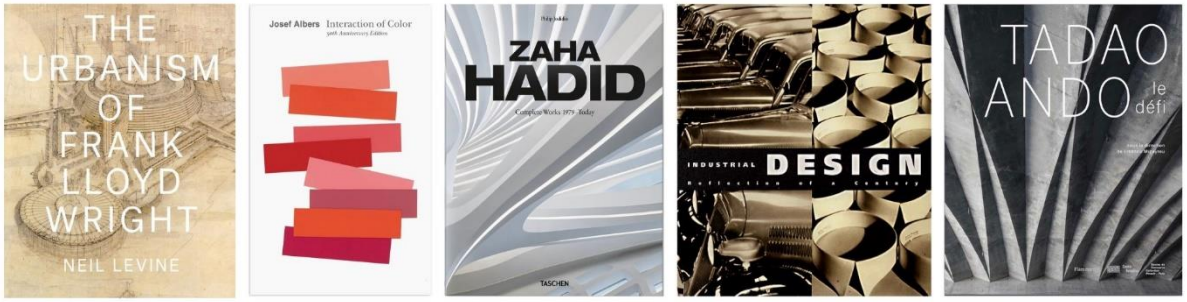

Figure 7: Book cover design featuring a range of tonal value-related colour strategies.

Conclusions

The colour attribute of tonal value figures prominently in traditional colour theory and occurs within colour education as well as professional practice related to applied design and design of the built environment. Using a survey approach, this paper discusses tonal value and provides a definition drawn from traditional colour theory. In addition, constructs related to tonal value are explored and examined in tandem with charts, scales and illustrations related to tonal value. In reference to design praxis and design education, value-related constructs have come to represent colour strategies that are commonly explored and applied across design education and contemporary professional practice.

The outcomes from this survey reveal that tonal value plays a key role in design and not only has the capacity to underpin design decisions relating to colour application but is considered an important consideration in respect to the aims and intended outcomes of design projects. From both a praxis and design education perspective, value-related colour strategies are considered to play an important role in colour application by contributing to differentiation, enhanced legibility, and environmental visual literacy as well as perceptions relating to mood, atmosphere, and ambience across applied design and design of the built environment.

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