6.3. The Concept of Colour Harmony in Environment Theory

Colour-bearing surfaces of our built environment have colours of different hues, saturations and lightnesses. In other words, they are perceived, and act in shaping the space as a complex, in interaction, rather than by themselves. The role of various colour sensations in modifying distance perception or expressing function can be discussed independently only theoretically; in a real space, space sensations are always formed by colour harmony complexes. Therefore the regularities ordering our colour perceptions to a harmony complex i.e. the content of the concept of colour harmony are problems of prime importance.

Surface colours of built space are important factors in the development of space sensation. The content of space sensation can be deduced from two components: space perception and its relation to the function of the real space. Colour perceptions are

present in both components as harmony complexes. Correlations ordering our colour perceptions to harmony complexes represent the content of the concept of harmony. Content of correlations affecting the harmony generates different levels of generalization. In this chapter three superimposed levels of the content of colour harmony will be discussed. The first level is closely related to colour perception. It involves relations valid for most people since they depend on the process of colour perception and can be explained by psychophysical relations. The second level involves the effect of the perceived colour complex on the observer's psyché. At this level, appreciation is affected by psychic, somatic, age, cultural, social features of the observer. The third level of the colour harmony purport is complex interaction between colour, man and environment. Thus, appreciation of harmony sensation depends on the environment of the colour complex, involving light, structure, material, but also spatial position and function. Colour harmony is always directly related to the aesthetic function of the environment.

6.3.1. Levels of the Formation of Colour Harmony Sensation

Content of the colour harmony sensation has several components such as colours of the complex, environment containing these colours, and man living in this environment and perceiving these colours. This relation is the more general, the more numerous are people for whom the same situation gives rise to the same harmony sensation. Depending on the general applicability of this harmony content, different levels of this content can be identified (Fig. 6.28).

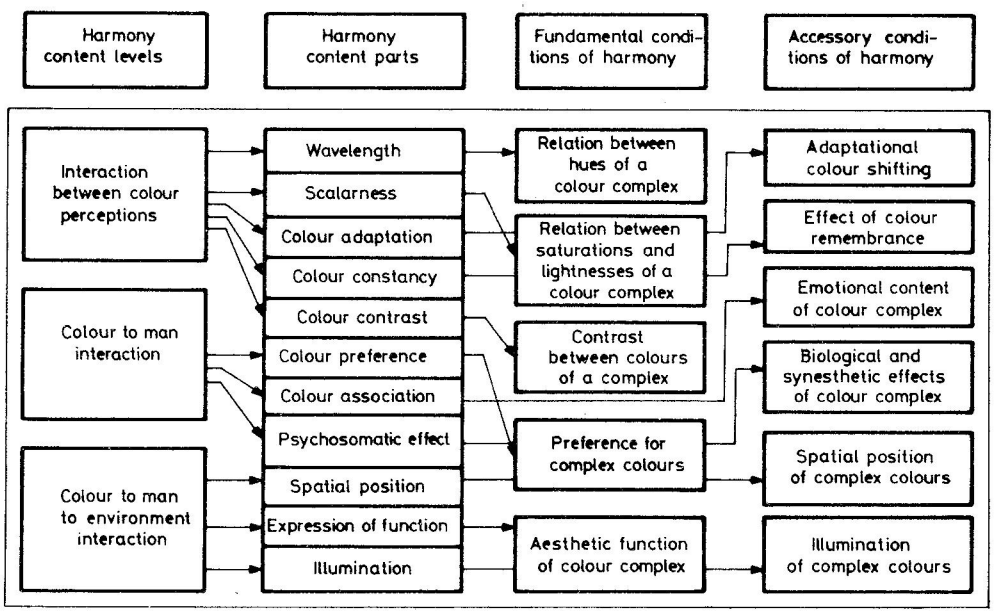


Fig. 6.28. Contents of the concept of colour harmony. Conditions of colour harmony sensation

Relations between colour perceptions
The content of colour harmony has three superimposed levels. One is perception, involving relations basically identical for everybody, since mainly resulting from the process of colour perception, and can be explained by fundamental psychophysical events. These relations express interactions between colour perceptions which can be described, in turn, in terms of relations between colour perception parameters: hues, saturations, and lightnesses of harmonizing colours. These relations lend names to the harmony types such as complementary harmony, triadic harmony, scale of equal saturations and others.

Relations between colour complexes and man
The second level of the colour harmony content involves the psychosomatic effects of the perceived colour complex on the perceiver. A proper relation between colour perception parameters in a certain colour complex does not elicit a harmony sensation in everybody. This sensation depends on the observer's age, sex, nationality, culture—and also on associations, and even, on psychosomatic effects elicited by the colours.

Relations between colour complexes, man, and environment
Perception of any colour complex, and harmony sensation resulting from it much depend on the spatial position of colours in the complex, their relative areas, illumination intensity, spectral power distribution of the light source, and direction of illumination, as well as on the environment function to be expressed by it, or simply, the function of the affected environment. These relations, the interaction between colour, man and environment, are the third level of the harmony content.

6.3.2. Components of the Content of Colour Harmony Sensations

Contents of colour harmony represent different levels, differently affecting the development of harmony sensations.

Wavelength
Colour formulations in everyday practice refer to harmony or disharmony of different hues, to statements such as: blue is seldom pleasant with green, but mostly it is so with yellow, forming a harmonic pair. Millennia of fine arts call our attention to the experience that certain hue combinations are more aesthetic than others. Harmony relations between hues can be primarily expressed by relations between dominant wavelengths of radiations eliciting colour perceptions. These relationships may be explained by the mechanism of colour perception, supported by recent countercolour theories.

Scalarness
In architecture it has been known for a long time that certain proportions between dimensions of space elements or their parts are more aesthetic than others. Such proportions have been deduced in Antiquity from the Pythagorean golden section. Similarly, the most essential factor of colour harmony is proportionality between colour parameters saturation and lightness, and a scalar relation between members of the colour

complex. Scalar is a relation where Coloroid saturation and lightness parameters of colours in the complex constitute a uniformly increasing or decreasing series. Scalarness expresses a regular relation between colour stimulus and colour perception. For instance, colour perceptions of a uniformly decreasing lightness scale are elicited by quadratically decreasing colour stimuli—approximating to the golden section.

Colour adaptation

It is known from experience that in a colour space which at the first sight looks pleasant after looking around for a few minutes, the harmony sensation raised often changes to the unpleasant. Or else, an impression not too pleasant at the first sight changes gradually to a harmonious experience. Eyes adapt themselves to the prevailing colour of the space; consequently, colour bearing surfaces seem to have changed their colours as compared with the first impression. This phenomenon follows from the mechanism of colour vision. It arises also in looking at the colour harmony of a planar surface, e.g. of a picture. Our sensing mechanism reacts on the same stimulus by a colour perception modified by the effect of the surroundings. This change has a different magnitude and tendency in every colour domain.

Colour constancy

Harmony sensation elicited by a planar composition or the complex of colour-bearing surfaces in the built space is not exclusively due to the harmony between colour qualities perceived. Colour appreciation cannot be dissociated from earlier memories imprinted by colour-bearing surfaces of particular forms. Perception elicited by a stimulus reaching the eyes from the surface is subjected to the modifying effect of remembrance. Since only some often encountered colour-bearing surfaces are remembered, this process sometimes markedly affects the development of harmony sensation, while on other occasions only negligibly.

Colour contrast

Only colour complexes with a contrast relation between at least one of hue, saturation or lightness parameters of its members are felt as harmonic. Magnitude and character of the contrast relation affect emotional message of the harmony. Lightness contrast has a rather dynamic and obvious message, while saturation and hue contrasts suit more subtle, emotional messages. There exists also a contrast relation between surface areas of harmonizing colours. Smaller areas are needed and sufficient from more intensive, more saturated colours to create harmonic units with adjacent duller surfaces.

Colour preference

Murals and fabrics of the early Middle Ages often exhibit colour complexes of English red, sienna and ultramarine colours generously applied also in plain colours. In contrast, Baroque buildings often displayed French gray, Sèvres green, Rosroside, palace yellow, and Medici blue. The early Middle Ages had colour harmonies different from those in Late Baroque. Preference for complexes of saturated, dark, warm shades were replaced for those of lighter, rather dull, cooler colours. Numerical values of colour parameters of complexes show regular relations in both periods, albeit quite different ones. Youth prefers colours different from those preferred by elderly people, and accepts different complexes as harmonic. Development of harmony sensation also depends on the preference for colours in the complex.

Colour association
Sight of some colour complexes raises emotional and conceptual messages. If an emotional message is unambiguously expressed by the colour complex then it is felt to be pleasant, expressive, harmonic. Otherwise, no harmony sensation is likely to be induced.

Psychosomatic effect
Red, orange raise blood pressure, yellow increases gastric juice secretion, blue and green attenuate the activity of the nervous system. Sensitivity to these colour effects and the like varies with the individual. Colour complexes with some people exert harmful biological effects, seem unpleasant in a room, raise antipathy, and the complex is felt to be unpleasant, disharmonic. In this case, aesthetic judgement is influenced by physiological factors.

Position in space
Some colours are not equally welcome on all colour-bearing surfaces of the environment. For instance, a light cobalt blue is less pleasant on the floor than on the wall, pink is unpleasant on the ceiling but acceptable as a pullover. Colour harmony sensation is affected or even impeded by ignoring experiences of this kind in deciding on surface colours.

Expression of function
Primrose yellow, cadmium red and Mitis green in a complex of uniformly decreasing lightness and saturation expresses exultant merriness. It is felt to be harmonic on the beach, in a circus or a bar, but in an office or medical consulting room we feel it to be disturbing, disharmonic. Emotional message of the colour complex in a room cannot be contrarious to its function. If the colour complex expresses the function of the space, the satisfaction of recognition adds to the aesthetic value of the colour complex.

Illumination
Intensity of a harmony sensation elicited by a colour complex also depends on its illumination. Depending on intensity, quality and direction of illumination, one and the same coloured surface may appear in different colours. Variable illumination may alter the individual colours in different ways changing thereby the aesthetic content of the complex.

6.3.3. Basic Conditions for the Development of Colour Harmony Sensations

Five among the factors contributing to harmony purports may be considered as fundamental and indispensable for the aesthetic content of a colour complex.

Relation between saturations and lightnesses in a colour complex
Based on tests outlined in the preceding subchapter we may state, that the fundamental condition of colour harmony is a scalar relation between saturations and lightnesses in the colour complex. The type of harmony depends on the character of these scales. A scale of lightnesses and decreasing saturations is a harmony complex with extremely fine,

almost decadent message, safe from emotional outbursts. Dark varieties of this scale suggest the thought of death, its light varieties were applied in Classicism. A scale of colours of equal saturation and decreasing lightnesses is somewhat coarse, but very dynamic, and is frequent in our age. Saturation and lightness scales varying in the same sense or in the opposite sense express richer, more definite and more vigorous messages than the former ones. Beyond these four fundamental scales, harmony relations are borne out by so-called boundary scales consisting of members containing white or black in varying proportions.

Relation between hues of the colour complex
One component of space perception is the visual appearance of material surfaces, in which hue is an essential factor. Relation between hues of the colour complex is determinant for the kind of colour harmony, distinguished as isochrome, group-wise, complementary, triadic and tetradic. The simplest and the most current ones are isochrome and group harmonies, preferred in this age, but also complementarity is known to be of importance for the harmony sensation. Its aesthetic significance makes it to excel among other hue relations, but it has no primary importance over other harmony contents as had been long believed. Triadic and tetradic relations are less important than is complementarity. Complementary harmonies are full of tension. Triadic and tetradic harmonies are less tense and richer than are complementary ones, and hold manifold messages.

Contrast relations between colours of a complex
Hue, saturation and lightness contrasts are fundamental conditions of harmony. Any form of the scalar relations above comprises one or more of these contrasts, but also quantity and quality contrast in the harmony complex are of importance. The message of the complex is affected by relative surface areas and surface appearances of the colours involved. Surface appearance includes texture and whether it is polished or lustreless.

Preference for colours in the complex
Essential determinants of preference for a colour complex are cultural and ethnic background, the surrounding landscape as well as sex and age of the subject. Beyond that, preference may also depend on physical and mental condition, or illness.

Aesthetic function of the colour complex
Harmony complex is a product with an aesthetic content, and as such, an elementary work of art. If it is present in the built space as the inducer of space sensation, it has to express utility and informative functions of space and its elements.

6.3.4. Accessory Conditions of the Development of Colour Harmony Sensations

The following conditions are not indispensable for harmony sensation, although when present, they help to generate it, and enhance the aesthetic value of the complex. Harmony sensation has six accessory conditions.

Colour shifting by adaptation
Adaptation permits the appreciation equally of a harmonic colour complex in spite of the slowly changing light conditions in different times of the day. Otherwise, since light intensity conditions are varying from minute to minute, this would prevent creation of harmony complexes for other than instantaneous light conditions and making the aesthetic content undefinable. Owing to adaptation, after a few minutes of looking at yellowish green, orange, red and purple, colour perceptions are shifted towards yellow, while green, bluish green and violet shift toward blue. Also the perception of saturation is much modified by adaptation.

Effect of colour remembrance
Colour remembrance elicits primarily the phenomenon of colour constancy. It modifies colours or well-known forms in space, and its effect can be eliminated only if the colour in the complex much differs from that remembered. Colour harmony sensation also affected by custom. The more habitual a complex, the more harmonic is it felt to be.

Emotional message of the colour complex
Under otherwise identical conditions, the complex with the more definite emotional message is felt to be more harmonic. Colour symbol systems in various ages consisted of harmony relations with emotional messages.

Biological and synesthetic effects of colour complexes
Under identical basic conditions, colour complexes with more favourable biological effects, and those suiting to elicit synthesis with another sensory organ, usually, with hearing, are felt to be more harmonious.

Spatial position of colours in the complex
Harmony sensation is also affected by which members of the complex are situated on a horizontal and which on a vertical surface, above or below the observer's horizon, nearer to, or farther from, the observer. Harmony development is also affected by articulation and shape of the colour-bearing surface.

Illumination of the colours of the complex
Variation of light intensity modifies saturation perception, that may reduce, in turn, the aesthetic content of the colour complex. If a harmony complex is devised under illumination by a light source of other than continuous spectral energy emission, spectral energy distribution of the light source to be used has to be reduced, since the aesthetic content of the complex unfolds only in a light of similar energy distribution. Oranges, yellows and reds are felt in back-light to be less saturated, and so are blues and greens in full light. Harmony sensation best arises in a built environment provided with diffuse illumination.

6.4. Kinds of Colour Harmony

Harmonic colour complexes may be classified according to relations between parameters of the composing colours. Depending on whether colours in the complex belong to one, two, three, four or more different hues, monochrome, dichrome, trichrome, tetrachrome,

or polychrome harmonies are spoken of. If there is a preferential relation between hues sharing the harmony, there is a diadic harmony, involving complementary, triadic and tetradic harmonies. There is a preference for a relation, where in case of complementaries, the two hues are at 180° in the Coloroid colour circle, while for triadic harmonies, three hues are at 130° and 230°, for tetradic harmonies, four hues at 34°, 130° and 230°, or at 130°, 230° and 326° from zero.

Every kind of colour harmony comprises several harmony scales. Colour complexes where numerical values of saturation or lightness parameters or both of the component colours form arithmetic or geometric series are called scales. Consequently, harmonizing colours have spatial loci in the Coloroid colour solid on straights, regular curves, or in simple geometric figures. Emotional value of harmony complexes is defined primarily by the relation between hues of the component colours, i.e. by the kind of harmony, while its dynamism by the scale type. Magnitude of harmony content in colour complexes depends on the regularity of colours in the complex. More regular complexes are more harmonious.

6.4.1. Monochrome Harmonies

For the simplest type of colour harmony complexes, members have the same Coloroid hue. For these monochrome harmony complexes, colour points of all the colours lie in the same Coloroid section. Colours of the same hue harmonize if numerical values of saturations and of lightnesses are in a regular relation, mostly forming arithmetical or geometrical series. This requirement not only applies to monochrome harmonies but is also valid for any kind of harmony.

Monochrome harmonies mostly have a definite emotional message conveyed by associations linked to the common hue of members of the harmony complex. This message is nuanced, and is given more dynamism or restraint by correlations between colour saturations and lightnesses, i.e. by the scale type formed by members of the colour complex. Let us consider the most typical scales.

Figures C61 to C63 show the same spot-like still life. Each of them was painted using five tones of Coloroid orange hue *A*20. Colour points for colours in Fig. C61 are equidistant on the straight line for saturation *T*12 parallel to the achromatic axis. Thus, colours in the still life have two parameters in common, those for hue and saturation; lightness parameters follow an arithmetic series. Since the scale is near the achromatic axis, it hardly shares the emotional effect of orange, but still makes a warm, sunny impression. Lightness scales are simple but always dynamic, and used often in our age.

Colours of the still life in Fig. C62 are of the same lightness but of different saturations. Colours are equidistant on the normal to the achromatic axis for lightness *V*70 in the Coloroid section. Every colour of the still life has the same hue and lightness, while saturations increase according to an arithmetic series. Such compositions are extremely fine, almost decadent. Even so, the subdued fire and light of orange transpires in this composition. Colour complexes of such a composition are called saturation scales.

Colours of the next still life (Fig. C63) have only the hue parameter in common, both saturations and lightnesses increase according to an arithmetic series. Colour points are equidistant along a skew line of the Coloroid section. Colour complexes comprising such scales are able to transmit rich, definite messages.

Beyond those detailed above, still many other scales are conceivable, differing slightly by their messages. Loci of members of Coloroid hue *A*66 of a scale of decreasing lightnesses and increasing saturations in the colour plane are seen in Fig. 6.29. If the numerical value of one parameter of scale colours varies according to arithmetic series, and that of the other according to geometric series, then colour points for scale members will lie on curves rather than on straights. Such are scales in Figs 6.30 to 6.33. Scales for Figs 6.30 and 6.31 are called boundary scales since their members lie on the boundary of the half-plane section of the colour solid containing surface colours. Scales in Fig. 6.30 are always fresh, give a clean impression, while scales in Fig. 6.31 have only colour and black content. Composing of colour scales has already been discussed in Chapter 3. Parameters of any member of a scale forming an arithmetical series is obtained from the

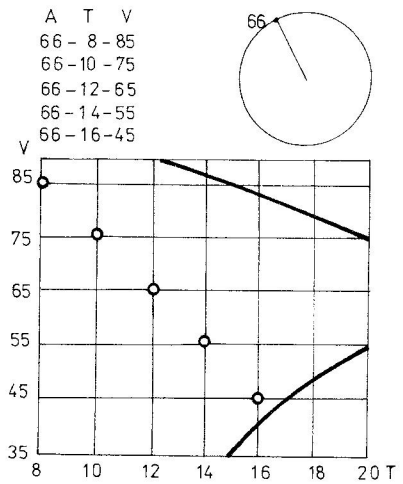


Fig. 6.29. Monochrome harmony

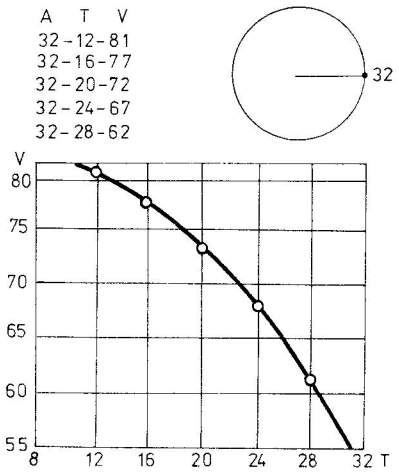


Fig. 6.30. Monochrome harmony

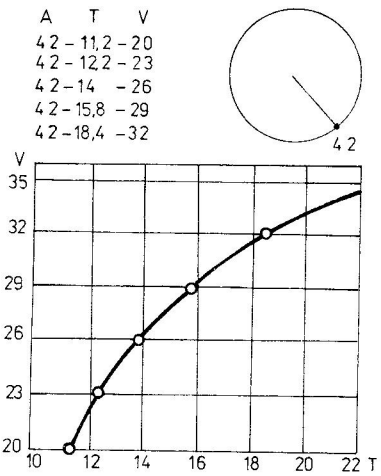


Fig. 6.31. Monochrome harmony

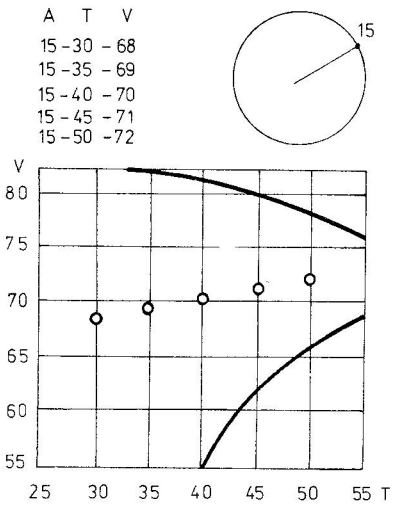
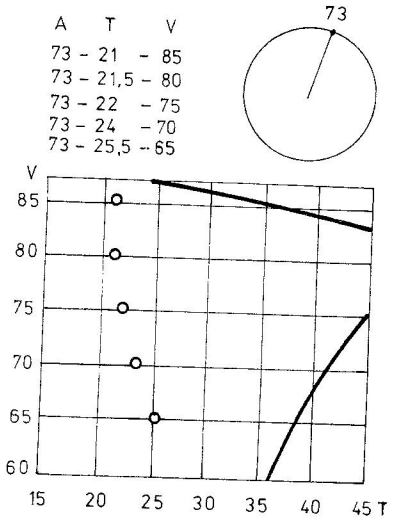


Fig. 6.32. Monochrome harmony

Fig. 6.33. Monochrome harmony



first term and the interval as:

$$a_n = a_1 + (n-1)d\,. \tag{123}$$

Any member of a geometric series is obtained from the first term and the quotient q as:

$$a_n = a_1 q^{n-1}\,. \tag{124}$$

In everyday practice, mostly duplicates or other variations of the described scales are encountered (Figs 6.32, 6.33). In this case colour points for scale members are on simple geometric figures in the given Coloroid colour plane. Colours for Figs C64 to C67 have been selected from the colour plane for Coloroid red *A*31. Four colours of the composition in Fig. C64 are colours common between two lightness scales and two boundary scales. This composition is light, fresh and vigorous. The composition in Fig. C65 comprises eight colours taken from two lightness scales; one of them has colours near the achromatic axis, the other has more saturated ones. This composition is richer, and somewhat more intensive but less fresh than the former.

Figure C66 has been composed of seven colours. Colours are those of a saturation scale and of a scale with members having saturation and lightness codes increasing according to arithmetical series. One colour of the composition is present in both scales. It gives a refined, delicate impression. Composition in Fig. C67 makes a much more vigorous but still rich effect. Eight colours of the composition are members of a dark boundary scale and of a scale parallel to it. Saturation values of the composition colours vary according to arithmetical series, and lightness values according to geometrical series.

6.4.2. Dichrome Harmonies

Harmony complexes where colours belong to two different hues are dichrome harmonies. Among them complementary harmonies have an outstanding importance by being harmony groups most saturated with tension. They always have a definite emo-

tional message, pointed out be referring to the opposite of this message. They are dynamic and manifold.

Figures C68 to C71 show spotlike still lifes like those before. Colours of composition in Fig. C68 are complementaries *A*20 and *A*54, of uniformly increasing lightnesses and saturations. This composition is built up on a tense balance between cold and warm colours. Composition in Fig. C69 is definitely cold due to greenish blue varieties of hue *A*56 enlivened by brown arabesques, low-saturant varieties of orange red of hue *A*25. Composition colours belong to two lightness scales near the achromatic axis. Lightness scales are not continuous but are divided into dark and light parts. The duller scale exhibits a wider, the less dull, a smaller gap. A peculiar, unbalanced group of harmony complexes is that of deficient scales such as that for the still life in Fig. C70. Composition hues are at 130° in the Coloroid colour circle. This hue relation always excels as aesthetic. Colours in this composition form a deficient saturation scale belonging to two lightnesses.

Composition in Fig. C71 is rather balanced, of somewhat concealed dynamism. Its colours form two scales of oppositely varying saturations and lightnesses. Colours in Figs C72 and C73 have complementary hues *A*11–*A*51. This complementary hue pair combines the most intensive lightness contrast to the highest dynamism. Composition in Fig. C72 is clean, intense, and dynamic. Colours belong to a lightness scale and to a scale of colours of uniformly increasing saturations and lightnesses. Intervals of this latter scale vary according to the rules of golden section. The more colours that are present in a complex, the more of scalar relations have to exist between its members. An example is the composition of twelve colours in Fig. C73. These complexes are always emotionally nuanced and manifold. Also composition in Fig. C74 comprises colours of complementary hues, belonging to two lightness scales. Multiple relations are illustrated in the explanatory drawing to this figure.

6.4.3. Trichrome Harmonies

Trichrome harmonies are more varied than are dichrome ones but less unambiguous in mood. Colours are selected from three different hues. Among them, triadic compositions are most noteworthy. In these compositions, hues are at about 34°–130°, at 130°–230°, or at 230°–326° in the Coloroid colour circle. The complex in Fig. C75 is a regular triadic composition, with colours arranged in a scale of uniformly increasing saturations and lightnesses, but differs from the previous ones by involving two or even three colours at some of its colour points, indicated by small concentric circles in the explanatory drawing. Hues in the complex of the next figure (C76) are no longer in triadic relation. Numerical values of both saturations and lightnesses form an arithmetical series. This composition is harmonically regular but not too exciting. Composition in Fig. C77 has more emotional content. Its hues are in a semilateral triadic relation and colours belong to two lightness scales.

Compositions in Figs C78 to C80 comprise colours of hues *A*35, *A*53, *A*72 in a regular triadic relation. Compositions differ by different regularity degrees of colour scales. Colours in Fig. C78 follow three lightness scales with gaps. This composition is felt to be somewhat gaudy. This feeling disappears when looking at the composition in Fig. C79, in spite of its more intensive, more contrasting colours compared to those in the

previous composition. Composition scales are again lightness scales but they are uniform, and equidistant within each scale. Composition in Fig. C80 is enigmatically ambiguous. Its colours may be arranged both in lightness scales and in scales of uniformly varying saturations and lightnesses. They are of low saturation and in a perfectly ordered relation.

A special type of trichrome harmonies is seen in Fig. C81. Two of the hues are rather close in the Coloroid colour circle, while the third one is at 34°, preferential for its harmony content. Such a complex is usually called group harmony. Its nine composing colours belong to two lightness scales with different intervals. This composition has a definite emotional message.

6.4.4. Tetrachrome Harmonies

Tetrachrome harmonies include, so to say, the entire the colour circle, hence they are rather variegated. Among them, tetradic harmonies are of special importance, with hues at 34°, 130°, 230°, or at 130°, 230°, 326°. They are sophisticated and require the utmost care to produce if every hue in the composition is represented by a single colour, such as those in Figs C82 to C84. Composition hues in Figs C82 and C83 are in a regular tetrachrome, and those in Fig. C84, in a special tetradic relation. Saturation parameters of colours in the first two figures are definitely scalar, and so are lightness parameters of colours in the third figure.

Again, Figs C85 and C86 show still lifes. The former is balanced, dynamized only by lightness contrast. Saturations of colours in the picture are within a rather narrow range and also hues balance each other. Still life in Fig. C85 is less balanced without being more dynamic. Hues are not integrated within the colour system of the picture, essentially due to unfavourable relative deflections within the colour circle, since all four hues are in the same half of the colour circle. Although the lightness scale of the composition has five intervals, the saturation scale has only three members. The most exciting and most dynamic composition is that in Fig. C86, with tetradic hue relations. Its scales are almost parallel, with increasing saturation and lightness. There is not only a lightness contrast but also an intensive saturation contrast.

Colours of every composition in the concluding series, Figs C88 to C91 belong to two hues of two complementary pairs each. Colours in all the four figures have hues of complementary pairs *A*11–*A*51 and *A*33–*A*61. Essential differences between compositions are due to scale differences. Composition in Fig. C88 is the most balanced one; its colours are arranged in two parallel scales. Composition in Fig. C89 is more turbulent, with less emotional message. Its scales are of different kinds and less ordered. There is little order among scale members in Fig. C90. In spite of its strong colours, the composition is without a definite message and looks gaudy. Scales of the last composition (Fig. C91) are again more orderly. The composition itself makes a sombre effect, still enhanced by yellow flashes.

6.4.5. Polychrome Harmonies

In everyday practice, polychrome is called a colour complex when colours from more than one hue domain, but in the theory of colour harmony mostly compositions with more than four hues are called polychrome. Here the latter interpretation will be used.

Polychrome complexes in this meaning are infrequent in environment design but current in painting. But even this polychromy may mostly be reduced to the basic situations discussed above. That is to say, polychrome complexes are only felt to be beautiful and harmonic if hues in the complex form groups. Now, extreme members of a hue group may be deflected by max. 6° to 8° within the colour circle. Polychrome complexes generally comprise a maximum of four hue groups each. A complex of more than four hues about equidistant on the colour circle will result in a gaudy composition.

In this chapter only the fundamental trends of colour harmony relations could be touched on. They are to be expounded in more detail in a monograph on colour harmonies, now being written.