# 5. Relations of Colour, Man and Environment

Man has created for himself a second nature, the built environment. Much of his life is spent in this man-made world. He is not only creator of this environment but also subject to its effects. To make our environment a home-like world, so that it should help—rather than hinder the development of our abilities, and to feel there at ease, requires—among other things—to make use of the power of colours, to investigate relations between colour, man and built environment.

This chapter is concerned with relations inherent in the man-made world not yet considered in this book. Relations between colour and space, colour and function, colour and illumination, as well as colour and ergonomics will be considered, all four relations being concerned with the system of relations between colour, man and environment, functioning, in fact, as a system. Relations between members of the system will be presented in diagrams.

## 5.1. Colour and Space

"Reality of a building is not its walls and roof but the space we live in"—said LAO TSE centuries ago. But what is space? What is meant by the concept of space? It is a commonplace concept—like material, motion, time—rather problematic for science but appearing self-evident for man as do everyday things.

Space is perceived from the first moment of life, continuously, with ever more sensory organs, yet it is hard to define. Everyday experience shows space in itself to be indefinite, and only mass—its opposite—makes it perceptible and definite for our consciousness.

This opposing unity between space and mass postulating each other—following partly from the nature of things, and partly, from the physiological features of perception—decisively affects the possibilities of space creation. Not space itself is perceived but relations between its three-dimensional elements, or at least, between elements with a plastic value, a relation expressed by direction, intensity, and quality of light, surface texture, and colours. Space does not exist in itself but by its effects elicited by these plastic elements. Consequently, it cannot be handled as some morphological pattern. Approach to the problem of architectural space is twofold: that of sensation, and of factors eliciting this sensation, hence, on one hand, the psychical process of space sensation elicited by the actual conditions, and on the other hand, composition, i.e. the spatial order of the eliciting plastic elements.

Composition itself is not restricted to the topological description of spatial elements, its essential features being also surface colours or spectral energy distribution of the light source.

Based on recent results of experimental psychology, the statement may be ventured that only physiological conditions of spatial vision are predetermined. Visual space perception is nothing else than innerved experience. Experiments using various colour saturation and lightness scales have proved that space sensation can be made not only ain but also contrarious to the topology of the environment. From the aspect of ing a desired space sensation, results of these investigations may be a more potent for the architect than modification of the space geometry.

## 1.1. The Role of Colour in Modifying Space Perception

y it is well known to everybody that warm colours seem to bring objects nearer, e cold colours appear to remove them. Again, anybody might have observed that n saturated colours are viewed against a black background, yellow appears to step ard, violet to recede, and the other colours are in between. Conversely, on a white nd, violet emerges with a mass effect, while yellow of similar lightness is repressed s C40, C41). These observations make it obvious that the spatial effect of a colour ays due to interaction with, and dependent on, neighbouring colours. As interesting ese observations are, they offer too little insight into the spatial effect of colours to the architect in expressing the wanted space sensation. Those concerned with ur, first of all, painters, have known much more about it since centuries ago.

n his "Trattato della pittura" LEONARDO DA VINCI, giant of the Renaissance, described ral observations on the effect of colours modifying space sensation, which have only ently been thoroughly reinvestigated in experimental psychology.

After having discovered line perspective, the Renaissance became interested in colour spective. As LEONARDO put it: "There is another perspective, that of the air: since air ferences permit us to recognize at what distances a building stands, even if the dings stand on the same straight line. For instance, if a great many buildings are seen nd the city walls that seem to reach to the same height above the walls, and you want epresent them as one being farther than the other then a somewhat hazy air has to painted, knowing that in such an air, farthest things, e.g. mountains, seem nearly blue, e air at sunrise, because of large air masses between them and the eye. Thus, the first ding over the wall should be painted its natural colour, the next one with a fainter ne, more bluish, that which is twice as far, should be made twice as blue, that five es farther five times bluer, and keeping this rule, it may be neatly recognized which e is farther, which one is bigger, and which one is smaller among buildings rising to e same height above the wall."

Following LEONARDO's train of thought, several centuries later ITTEN (1961) concluded m his tests that the scale of the spatial depth effects of the six basic colours followed e proportion of golden section. That is to say, placing orange between depths expressed yellow and by red, spatial depths expressed by these colours, that is, yellow to orange, d orange to red, are in a proportion to each other like the smaller to the larger distance he golden section. The same proportion exists between yellow and red, and green and e, yellow and green, and green and blue.

Again, it was ITTEN's observation that among cold and warm colours of the same tness, warm ones tend forward, and cold ones to the depth. Complemented by a light dark contrast, the cumulative effect is more pronounced. If bluish green and orange d of the same lightness lie on a dark surface, bluish green appears to be behind, and nge red before the surface. Making bluish green lighter, its apparent spatial position tend to that of orange red.

n their quoted statements, LEONARDO and ITTEN attributed space effect variation to

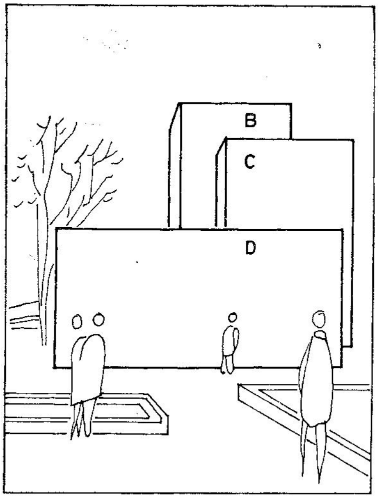



Fig. 5.1. Vertical walls outdoors at different distances from the observer, as colour bearing surfaces

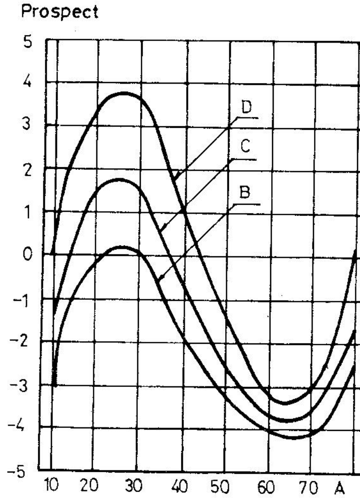



Fig. 5.2. Distance perception modifying effects of different hues on surfaces in Fig. 5.1. in prospect units, taking the medium saturated, medium light colour of hue *A*10 on surface D as reference

hue variation. These are statements which are now well known—although not always applied—by every architect. But variations of other colour parameters may also modify space sensation. As LEONARDO wrote: "If the same colour is at different distances but at the same height, it has to be lightened in the proportion to its distance from our eyes." Elsewhere, concerning saturation, he stated: "Colours in the foreground should be simple, the gradient of their decrease should be in accordance with the gradient of their distances, that is, the closer the object, the more it has to assume the nature of the viewpoint, and the closer the colours to the horizon, the more they adopt the colour of the horizon."

About the combined role of saturation and lightness in modifying space sensation LEONARDO wrote the following: "With increasing distance, first, the outlines of adjacent bodies of similar colours disappear, e.g. of neighbouring oak trees, at the next greater distance, outlines of objects differing by medium dull colours, such as foliage from fields, or abutments, or crumbling hillsides and rocks, while the last to blur are outlines of bodies confined by darkness at their light sides and by light at their dark sides."

To all this ITTEN added: "Saturated colours seem always nearer than dull colours of the same tone value. Adding this relation to that of cold to warm offers even richer possibilities for the apparent spatial location of various colour values." Later he stated: "For the creation of apparent spatial position of colour values, quantities of occurring colours are also decisive. Yellow on red background rises to float before red, but upon increasing the yellow area to exceed the red one, red seems to overtake yellow." (Fig. C42).

These statements refer mainly to free-standing vertical space walls. Based on observations by LEONARDO, FRANCESCA, VAN GOGH, PISARRO, ITTEN, WILSON, BIRREN, FRIELING, DÉRIBÉRÉ, and the Author, Figs 5.1 to 5.4 show variation of the perceived distance from free-standing vertical walls bearing colours of different hues, saturations and lightnesses. As reference was taken the perceived distance from wall D in Fig. 5.1, the nearest to the onlooker, bearing a Coloroid colour A10 of medium saturation and medium lightness.

The rate of decrease or increase of the reference distance perception has been expressed in "prospect" units (NEMCSICS, 1976). Zero point of the psychometric scale introduced for this purpose is the distance perceived from wall plane D under the circumstances outlined. The prospect values plotted are relative values expressing merely tendencies to modification of space perception.

Nevertheless, even the knowledge of tendencies is a valuable information for the designer. Orange of Coloroid hue 24 reduces while cold green of Coloroid hue 65 …mally increases the perceived distance. In case of warm colours, the modification of distance perception is much affected by the distance of the colour bearing surface from the observer, a factor rather irrelevant for cold colours (Fig. 5.2).

Slight saturation differences between unsaturated, or even, very saturated colours hardly affect the distance perception, while even the slightest saturation change of medium saturated colours markedly affects the distance perceived. Thus, in the coloration of e.g. façades in a street, if colours of medium saturation are to be applied, then … scales of the same hue may be selected. But there is free choice between either unsaturated or very saturated colours (Fig. 5.3). It is not generally known that the increase of distance perception is not proportional to lightness increase (Fig. 5.4).

Concerning colour bearing surfaces of horizontal planes or interiors, much less has been reported in the literature about modifications of the space sensation. Test results are seen in Figs 5.5 to 5.8, space sensation being again expressed in prospect units.

Blues and greens on the ceiling of a room increase space sensation much more than on the floor, while on the floor, colours in the red and purple domains are less depressive

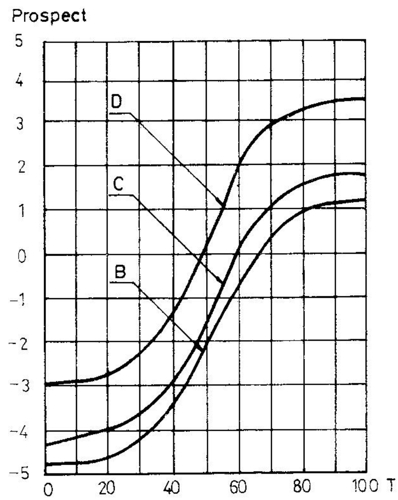



Fig. 5.3. Distance perception modifying effects of colours of different saturations on surfaces in Fig. 5.1. in prospect units, taking medium saturated, medium light colour of hue $A10$ on surface D as reference

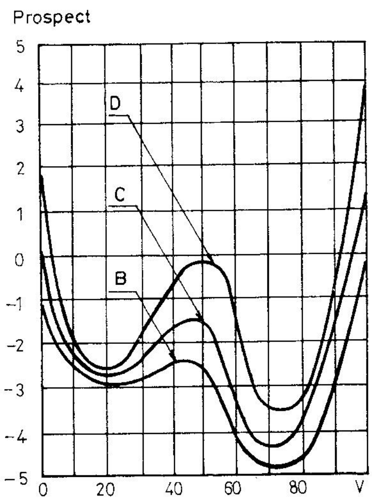



Fig. 5.4. Distance perception modifying effects of colours of different lightnesses on surfaces in Fig. 5.1. in prospect units, taking medium saturated, medium light colour of hue $A10$ on surface D as reference

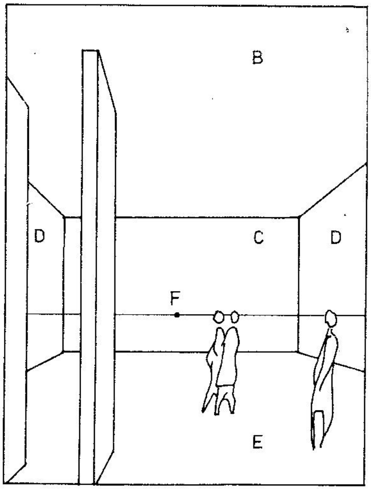



Fig. 5.5. Interior colour-bearing surfaces in different positions to the observer

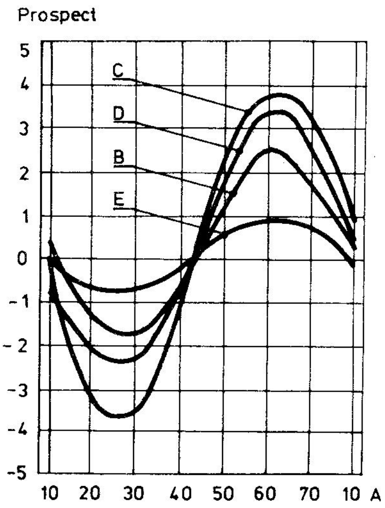



Fig. 5.6. Distance perception modifying effects of different hues in Fig. 5.5. in prospect units

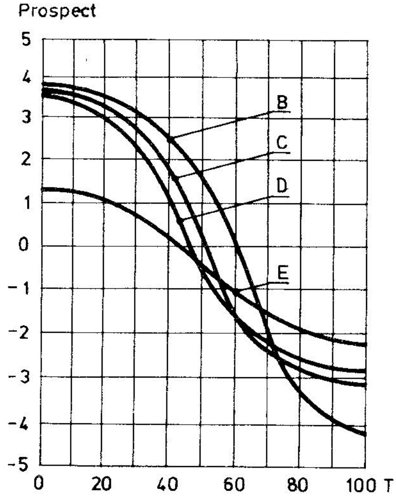



Fig. 5.7. Distance perception modifying effects of colours of different saturations in Fig. 5.5. in prospect units

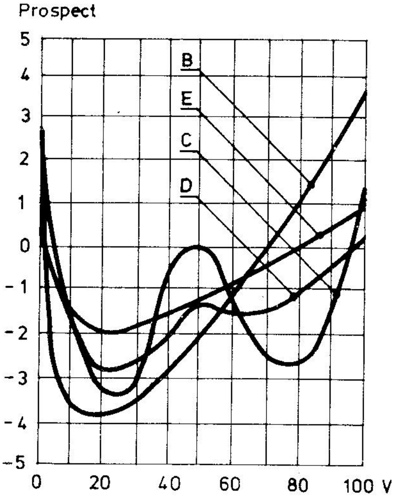
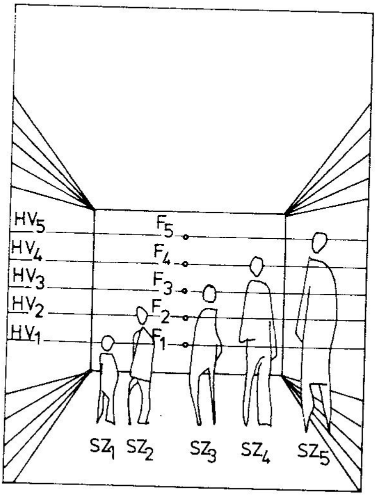



Fig. 5.8. Distance perception modifying effects of colours of different lightnesses in Fig. 5.5. in prospect units

than on the ceiling. In a low room, the ceiling requires less saturated colours than the floor. Depending on the hue, colours of about Coloroid saturation T20 and Coloroid lightness V70 induce the same space sensation modification on the ceiling and on the floor. On walls, the hue of the colour is decisive for the modification of space sensation, while on the ceiling, saturation and lightness are dominant. Thus, colour designers have to concentrate on hue for walls, and on saturation and lightness for the ceiling.

...pical problem encountered in the practice of interior colour design is that in case ...stant proportions, in what direction variation of absolute dimensions of a room ...s the space sensation modifying effect of various colours. Or, what are the effects ...mensions and proportions of colour bearing surfaces in this respect. Relevant ...rams based essentially on our own observations are seen in Figs 5.9 through 5.12.




... Ceilings as colour-bearing surfaces of rooms ... same width but of different headrooms

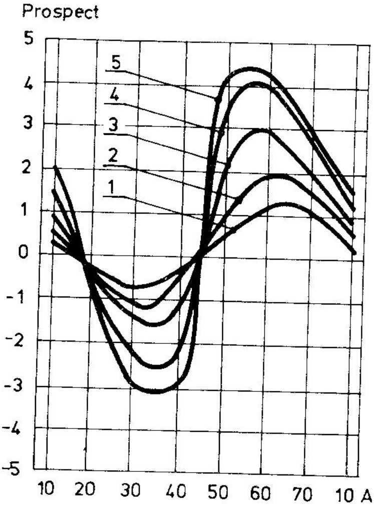
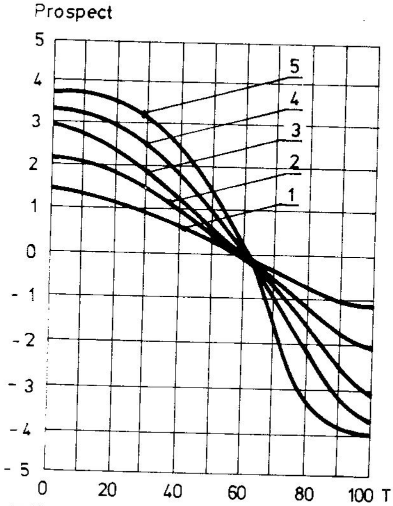



Fig. 5.10. Effects of colours of different hues on ceilings in Fig. 5.9. on increasing the headroom in prospect units




... Effects of colours of different saturations ...ngs in Fig. 5.9. on increasing the headroom in ... units

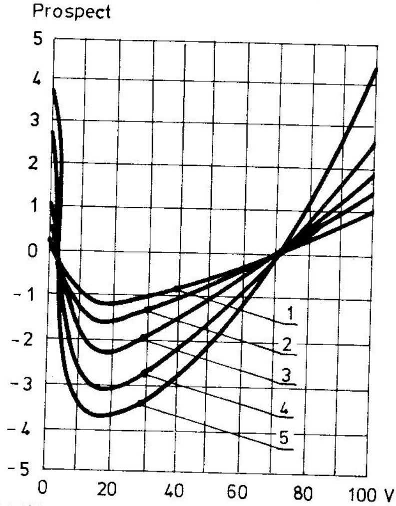



Fig. 5.12. Effects of colours of different lightnesses on ceilings in Fig. 5.9. on increasing the headroom in prospect units

## 5.1.2. Mass, Building Component, Surface, Form

It is common knowledge that in a home, red upholstery is more momentous than is e.g. a gray one, or that a white dress appears to make the wearer fat, while someone wearing a gray or black dress seems slimmer. But it has also been stated that bulky furniture should not be painted red or any other saturated colour lest it will look even heavier. If the impression of importance or mass of an object is to be enhanced, it should be colored either very light or very saturated.

Our observations concerning objects have been recapitulated in Figs 5.13 and 5.14. Mass of the chair in Fig. 5.13 is felt to be larger or smaller depending on the relation between the colours of the chair and the background. In Fig. 5.14, modification of mass perception with the variation of hues of a chair and its background has been plotted. Modification of mass perception has been rated from 0 to 10 on a special psychometric scale, in "mass" units, 10 masses being the maximum modification of mass perception. On the horizontal axis of the diagram various background hues are marked, the vertical axis shows modification rates of mass perception. The curves show the rates of modification for chairs of different colours. Modification of mass perception is in strict linear correlation with the hue contrast between chair and background. Different hue contrasts result in different mass sensation modifications. Modification is at maximum when a yellow chair is placed before violet background. Mass perception modifications as a function of variations of saturation and lightness of chair and background are shown in Figs 5.15 and 5.16, respectively.

The effect of colours to modify mass perception is of special importance in the colour design of streetscapes and of townscape complexes. Streetscapes of historical town centres usually comprise different building masses. Design is often expected to shape different masses into an assembly of units eliciting similar mass perceptions. Or even, a building lesser by mass but more important by its function or historical value has to be highlighted by eliciting an increased mass perception.

In Fig. 5.17, a streetscape consisting of ordinary buildings is seen. Façades differ by surface areas, being larger or smaller than the average. Deviations have been plotted in

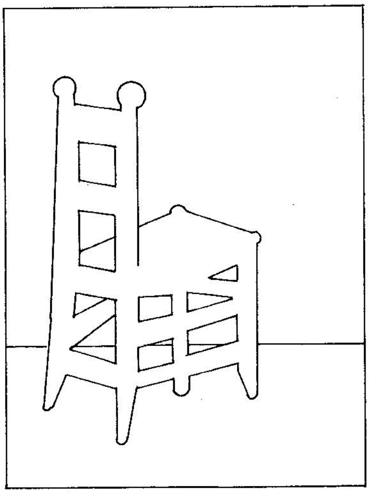
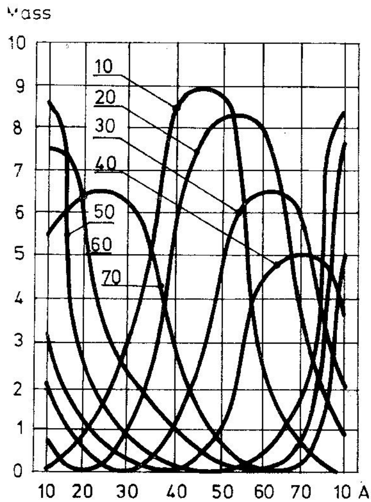


Fig. 5.13. Colour-bearing surface as a mass before different backgrounds




- Mass perception in mass units elicited by a ...ted with colours of different hues, before ...nds of different hues, as in Fig. 5.13. Hor... shows hue of the background colour, ... the magnitude of modification of mass ... Curves refer to chairs of colours of dif...roid hues

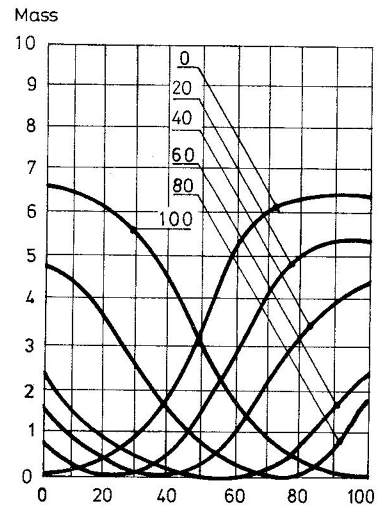
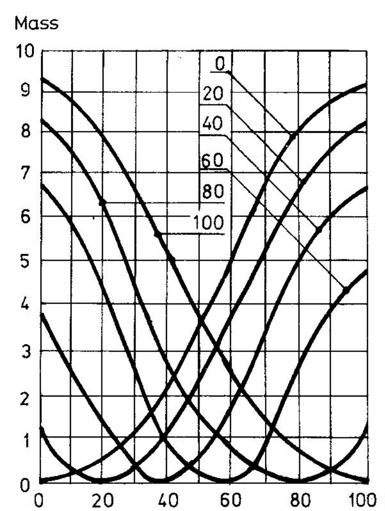



Fig. 5.15. Mass perception in mass units elicited by a chair painted with colours of different saturations, before backgrounds of different saturations, as in Fig. 5.13. Horizontal axis shows saturation of the background colour, vertical axis the rate of modification of mass perception. Curves refer to chairs of colours of different Coloroid saturations




Mass perception in mass units elicited by a chair ...th colours of different lightnesses, before background ... lightnesses, as in Fig. 5.13. Horizontal axis shows ... the background colour, vertical axis the rate of ...n of mass perception. Curves refer to chairs of col...fferent Coloroid lightnesses

...hasis diagram, so that the designer may know which building in the street has to ... a more saturated or a lighter colour to alter the mass effect, or perhaps a hue ...ng from its environment.

...skyline may have as background the blue of a fair sky, or the gray of an overcast ...tering the effect of different hues, saturations or lightnesses on the mass sensation. ...ations of mass sensation for facades of different hues, saturations and lightnesses

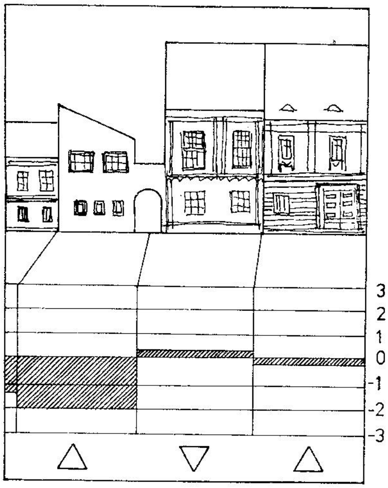



Fig. 5.17. Construction of an emphasis diagram for balancing surface proportions of a streetscape by colour

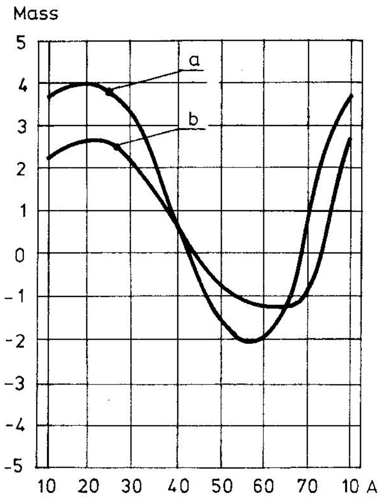



Fig. 5.18. Increase or decrease in mass units of façade surfaces in colours of different hues with a fair (a) and gloomy (b) sky as background. Horizontal axis shows hue of the façade colour, vertical axis the modification of mass perception

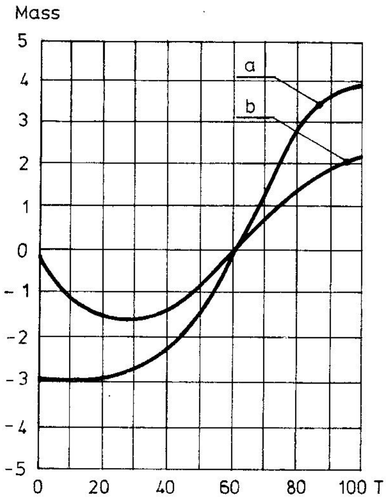
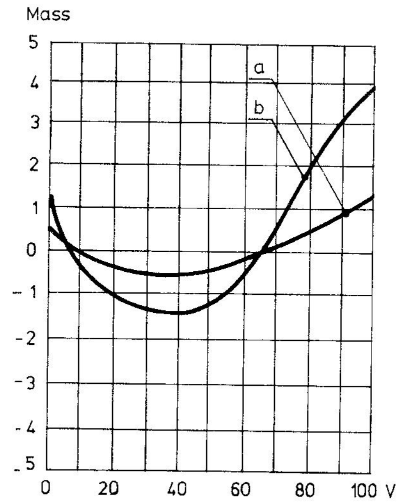



Fig. 5.19. Increase or decrease in mass units of façade surfaces in colours of different saturations with a fair (a) and gloomy (b) sky as background. Horizontal axis shows saturation of the façade colour, vertical axis the modification of mass perception

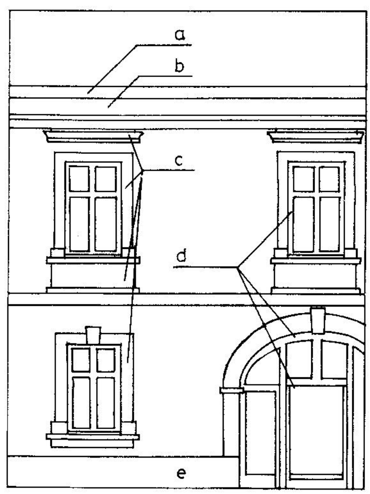
before a fair or overcast sky were plotted in Figs 5.18 to 5.20. Hue and lightness are effective mainly before a fair sky, while saturation mainly before an overcast sky.

There are different relations between building components, such as courses, pillars, doors and windows, which are in different relations between each other and with the wall surfaces. In addition to function, these components carry aesthetic messages; both can be expressed by colours. Unimaginative streetscapes are enlivened and are given a message, if a proper relation between colours of window casements, cornices, and the walls is established. Colour relations by hue, saturation, and lightness between building

...ents and wall surfaces are plotted in Figs 5.21 to 5.24. Clearly it is advantageous ...e hues of door and window frames, courses and footings akin to that of the wall, ... rather different saturation and lightness. On the other hand, hues for door and ... casements and sashes should preferably differ from those of the walls.
...earance of coloured surfaces is much affected by surface texture and material. The ... bearing surface may be perfectly smooth, coarse or granular. Different surface ...es have a different optical appearance, and hence elicit different sensations.
...ur is markedly affected by surface texture. This fact becomes clear upon changing ...ture of the coloured surface within the same group of colours. Let red, yellow and




... Increase or decrease in mass units of façade surfaces ...s of different lightnesses with a fair (a) and gloomy ...s background. Horizontal axis shows lightness of the ...our, vertical axis the modification of mass perception




... A façade with features: a) gutter, b) cornice, ... d) casement, sash, e) footing

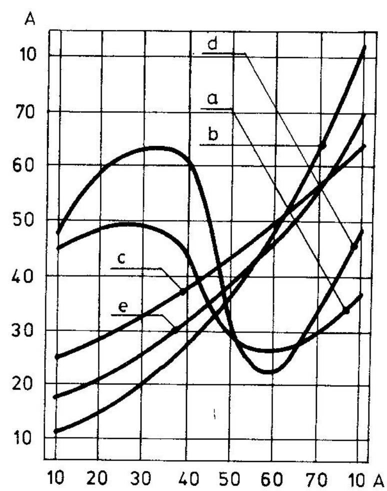



Fig. 5.22. Hues fitting the courses in the façade in Fig. 5.21 matching walls painted to colours of different hues. Horizontal axis shows wall colour hues, vertical axis the hue of the course colour

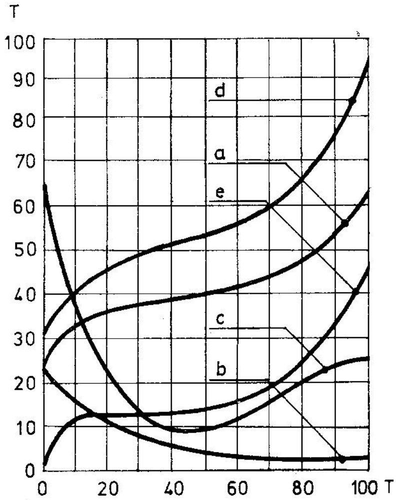



Fig. 5.23. Saturations of courses in the façade in Fig. 5.21, matching walls painted to colours of different saturations. Horizontal axis shows wall colour saturations, vertical axis the saturation of the course colour

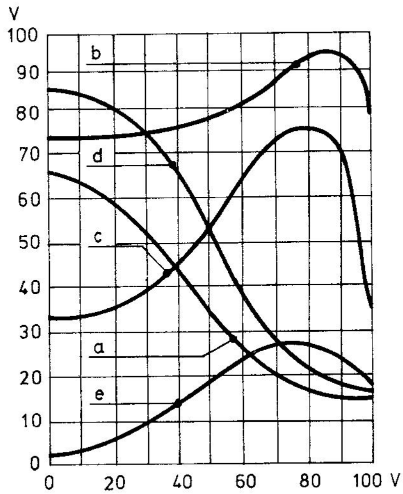



Fig. 5.24. Lightnesses of courses in the façade in Fig. 5.21, matching walls painted to colours of different lightnesses. Horizontal axis shows wall colour lightnesses, vertical axis the lightness of the course colour

blue stripes be painted on a surface. Covering one of the yellow stripes by a silk band of the same colour, the overall effect will dramatically change, due to different surface of silk. Let us make another test by painting a smooth sheet of paper and a surface of fresh plaster with the same green. Now a yellow circle should be painted onto the green paper, while a smooth yellow disc should be stuck onto the green plaster slab. The colours are the same in both cases, but messages of the two combinations will be quite different. Compared to the pleasant, lively plaster surface, the smooth paper will have a boring and featureless appearance.

The quality of textiles, silk or velvet, timber or marble, or other objects raises peculiar optic effects. Surface texture of materials lends special dynamism to colours. Timbers produce varied, warm colour effects. Stone gives a cold impression and so do colour values associated with stone. Tweeds are loose and light, and feel at ease with unsaturated, light colours. On the other hand, velvet is dense, heavy, and respectable and is impressive, mainly when dark coloured. For space creation architecture utilizes an assembly of forms and colours. Therefore it is instructive for the designer to contemplate relationships between forms and colours. Let us examine the relation between messages of some basic figures and colour values.

A square is characterized by two pairs of parallel straight lines, horizontal and vertical, symbol of material, weight, definiteness. For instance, among Egyptian hieroglyphs, the square stood for a plot of land. Figures containing perpendicular lines bear heavy stresses. A square is the counterpart of red. Both symbolize material. Both express what is heavy, opaque, static.

A triangle represents an angle, a diagonal—in general, an intersection. It has an agressive effect, typical of all diagonal configurations such as the rhombus, trapezium,

…th. The triangle is also an expression of aggressive thinking, thus it has to combine …ellow to express fully its message.

…e circle, rotation around a centre, performs a closed motion. Rather than by a hard, …ted, opposite motion typical of the square, the circle is characterized by con…s. relaxed motion; the circle, just as blue, symbolizes thinking. Thus, a circle …ming a continuous, closed motion has blue as its counterpart. Associative relation… between given colour values and configurations is not restricted to the pairs square …ed, triangle and yellow, or circle and blue, but it exists also between a wide range …nar or spatial forms, and various colour values.

## 3. Appearance

…arance of a building depends on several factors, one of which is colour. Colour is …y the dress of a building but an integral part of architecture. Function, structure, … and colour are inseparable, which means that colour of a façade, the harmony …a of a streetscape, or colours of a city cannot arise from an arbitrary decision. … selection is inseparable from architectural creation. Function influences struc… structure form, and form colour. Obviously, the process of creation is much more …ex than to assume such a single, hierarchic sequence of actions. Colour is directly …ed not only to form but also to structure and function, and also to all the close and …vironment of the building.

…as necessary to point all this out since nowadays, more than ever before, man … to see his environment, his entire built world, in visual unity, inducing him to … integrated colour design and repainting not only of streetscapes but even of whole …s. And this is all right, because our environment badly needs a considerate, …ed, architecture-derived intervention reflecting the visual approach.

…ow, authentic colour traditions associated with regions, architectural styles, and … functions have been almost completely neglected giving way to many different, …ently existing philosophies of colour design. Colour has often become a means …-expression of the artist, or it is present only as the natural colour of the building …al. Some architects either confuse a streetscape with a painting, or believe in the …ce of "pure" forms and pure architecture, independent of colours. What is more, … day possibilities of coloration have become almost unlimited. There is not only …e of harmonizing earth pigments of a particular region available, but an infinity …des are offered by the chemical industry. To what use? Some of our towns are …ed of colours, are gray, and bleak—others are too coloured, showing a gaudy and …ing picture. This can be helped by designing building coloration taking environ… …unction, and the system of their structure and form into consideration.

… wider environment involves geographic features. A mediterranean sunlit environ… …imulates white, and light tones. A white building before a blue sky sparkles with …ess, at the same time suggesting stability. But in a northern, foggy landscape, the … colour has an uncertain appearance lost in its surrounding. It seems fresh, and …ly if combined with intensive, fiery colours. In sunless regions, on façades highly …ed colours in contrasted pairs are at ease. Red, orange and yellow are revived by …e, while blue and green show better in shadow. Orientation is therefore an …ant point, mainly in the coloration of façades in a streetscape. In knowledge of