Hans Fog

COLOUR FORUM

ON LIGHT, COLOUR AND THE FCM

Why propose a new colour model? And why the FCM?

Over the years many architects, artists and researchers in Sweden and Norway have used the colour atlas of the Natural Colour System (NCS). I found it however unsatisfactory, and began to suspect that the problem was not the colour nuances that the atlas contained but those that were not there. Returning to the theory from which the NCS atlas had been developed, I found that black and white were represented at a distance one third shorter, as measured from the centre, than were the four unique colours in the theory's colour circle. This anomaly meant that the four colours red, yellow, green and blue would be overrepresented. Moreover, I found no good reason why black and white should not be seen as an antagonistic pair, equivalent to either of the two colour pairs in the NCS colour circle. After all, each of the six colours in the three pairs has the unique quality of lacking all similarity with the other five. Further, in my view there was a seventh colour with a similar, unique quality, which was not presented as an independent entity in NCS theory, namely grey. Grey differs from the other six colours in one respect only and that is in having no antagonist colour. These seven unique colours became the starting point for the development of a new colour model, which for consistency and simplicity has been expressed in terms of a sphere. I have called it the Fog Colour Model (FCM).

The night was so dark that I could not make out the objects around me, but had to rely on touch and sound to get my bearings when I moved about the room. Then from the window the first light of dawn began to give shape to my surroundings. The surfaces which reflected the weak light were pale grey. The areas which did not reflect this light were dark grey. A three dimensional world began to emerge in a scale of greys, from strong to weak grey. For a moment I saw the world around me as a completely colourblind person would.

As the intensity of the dawn light increased the surfaces which had been pale grey became a golden white. The dark grey surfaces became blue-black. The medium grey object which had stood out against a pale grey background now revealed itself to be of a clear red colour. A petal which not so long before had appeared as grey was now an increasingly intense yellowish green. With the returning light I could experience the full effect of colour vision on the eternal world of forms.

Now the sun was rising and I looked out. The sky was clear. Sunshine coloured one side of a snowdrift a brilliant yellow-white. The other side of the snowdrift was still in shade and shone bright blue, taking its colour from the sky. After a while clouds covered the sky and the light became diffuse, rather grey. The snowdrift that had shone with yellow and blue was now just a whitish grey. The colour shifts that the snowdrift underwent before my gaze were a result of interaction between the white surface of the snow and the varying colours of light. The object I was looking at had no single definite colour; rather, what I saw when the light fell on its surface was the result of a continuously changing interaction between surface colour and the colour of light.

Yet despite all these changes, my memory chooses to see the snow as white. And memory assigns to the forest beyond the snowdrift a single deep green colour, regardless of its many nuances. I recall the sky as bright blue. And a piece of charcoal from the fireplace becomes a flat black colour in my memory, despite the bright glittering surface that it had. Thus step by step through life, a collection of colour memories has been built up and adapted so that I can find what I am looking for and exclude what I do not find meaningful.

Through their relative constancy, memory colours allow for comparisons between the flow of changing colour impressions and one's own experience of what is useful or not useful, pleasant or unpleasant. According to life situation, every individual creates a unique collection of memory colours having personal meaning.

For the field of vision and memory colours to work together, the visual sense needs a number of relatively stable reference points that can order the flow of colours from the surrounding world according to the memory's choice of meaningful colours. Human colour vision has a number of such relatively constant reference points in six main colours. The six colours which each of us identifies in a similar way are blue, yellow, white, black, red and green. These colours have the intrinsic quality of forming pairs, the three pairs being blue and yellow, white and black, red and green, where the two colours in each pair are antagonistic and therefore cannot occur simultaneously in a single nuance of colour. This theory of antagonistic colours has been one of the basic influences on the Fog Colour Model (FCM) which I shall here describe in outline.

The theory of antagonistic colours can be illustrated with the pair red and green. Let us imagine that maximum red is located at one end of a line where the other end of the same line represents maximum green. The two colours are therefore linked to each other, but cannot occur simultaneously. Practical experience tells us that red can be neutralised with grey without its redness becoming bluish, whitish, yellowish or blackish, as the redness diminishes at the same rate as the greyness increases. At the point where grey reaches its maximum all redness has disappeared. This point is neutral grey.

In the same way, green can be neutralised by grey and finally disappear at the same neutral grey point. This neutral grey point both divides and unites the antagonistic colours in the pair red and green. In the same way the other colour pairs can be both divided and united at a neutral grey point. If this point is the same for all three colour pairs and the main colours are positioned for maximum discrimination then a three dimensional cross is formed from the three lines at right angles to each other. The illustration in Figure 1 is based on these three lines.

Just as red can interact with grey by reducing in proportion at the same rate as grey increases its proportion in the sequence of nuances between maximum red and maximum grey, so can red also interact with yellow, white, blue and black. Around the point at which the proportion of red and yellow are equal there is a sequence of orange nuances. When red interacts with white, a sequence of pink nuances appears, while in an interaction with blue, a sequence of violet nuances results. When red interacts with black, reddish brown nuances will appear.

Red can also interact with two other of the six main colours but never with more than two because the other three are antagonists. If red interacts with yellow and white, there appears in the field between these three colours a cluster of whitish orange colours. If red interacts with white and blue the cluster will be of whitish violet colours. With the interaction of red with blue and black, this will result in a cluster of black-

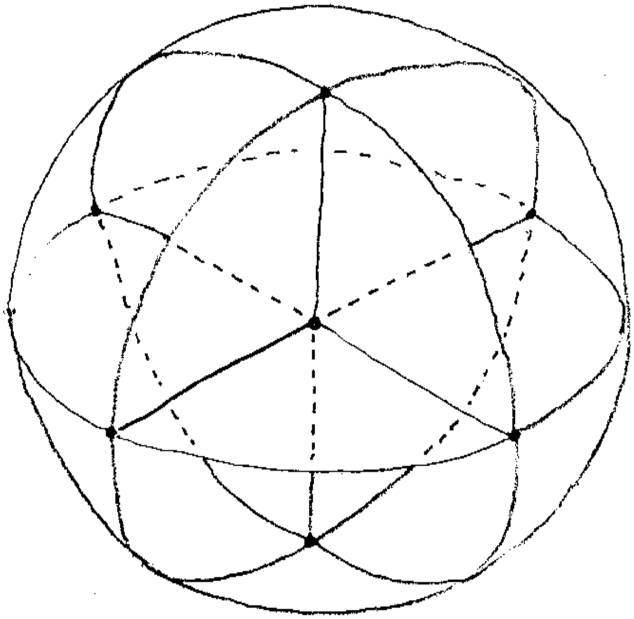

Figure 1.
The figure shows the three axes with antagonistic colour pairs at the ends of each axis. In the centre of the sphere the three axes cross. This centre represents neutral grey without any other colour component. Also shown are the six interlocking hemispheres, one of them seen from underneath and the opposite one seem from above, one at the back and its opposite at the front, and one hemisphere on the left and its opposite on the right.

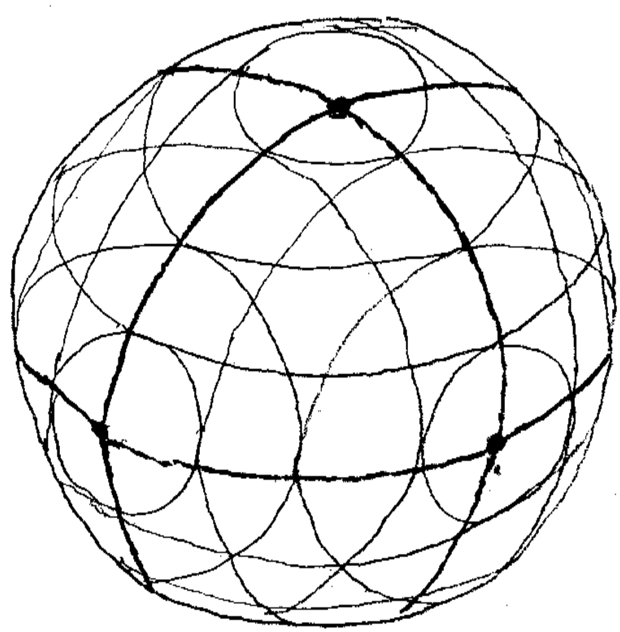

Figure 2.
The figure shows the surface of the FCM colour sphere with the poles lying where the circumferences which divide the hemispheres intersect each other. From each pole's maximum, the primary colour of the pole reduces in its proportion of every nuance in all directions, and disappears completely at the circumference which divides that pole colour from its antagonist. The smaller circumference which is shown nearest the pole marks the proportion 0.75 of the pole's colour. The next largest circumference marks the proportion 0.5 and the one after that marks 0.25 of the pole colour

ish violet nuances between these three main colours. When red interacts with black and yellow, the cluster in the middle of the field will consist of brown nuances. Just as red can interact with four other main colours in sequences of two colour interactions, and in four fields of three colour interactions, in the same way the five other main colours can interact with each other, antagonistic colours excepted.

If the infinite number of nuances which arise in the interaction of two or three colours interact with grey in the same way as the three main colour pairs, with the same distance between maximum nuance and maximum grey, this can be represented as a sphere with six poles. Neutral grey is at the centre of the sphere, as shown in Figure 1. The neutral grey centre of the sphere divides and unites not only the three main colour pairs but all the antagonistic nuances in the whole colour universe.

The six poles on the sphere's surface mark the centres of six hemispheres. Opposite the yellowish hemisphere is the bluish one. Opposite the greenish hemisphere is the reddish one. From a maximum at the pole the main colour's proportion reduces on each hemisphere's surface in all directions towards the largest circumference, where the value of the main colour becomes zero and in the same circumference the antagonist colour's value also drops to zero. In this way, the conditions for antagonists are fullfilled on the surface of the sphere as well as within it.

In the circumference which differentiates between the yellowish and the bluish hemispheres, are the poles for the other four main colours, that is, for white, red, black and yellow. In the circumference which differentiates the whitish from the blackish hemisphere, are the poles for yellow, red, blue and green. In the circumference which differentiates the reddish from the greenish hemisphere, are the poles white, yellow, black and blue.

Within these circumferences are the twelve sequences where two main colours interact. The three circumferences define the eight three-sided fields on the sphere's surface where three primary colours interact, as shown in Figure 2. This illustration also shows how the main colour of each hemisphere diminishes in all directions from pole to circumference. FCM describes only relationships between colours and does not encompass other aspects of importance to how we experience colour in the environment, such as the aesthetic, practical or symbolic dimensions. The parts of the colour universe which are differentiated and developed in detail depend on what meaning those parts have for the individual's daily life in the physical and cultural surroundings. A fisherman concentrates on other parts of the colour universe than does someone living in a large city. An artist sees many nuances of an object where a person with other interests sees only a single nuance. The ability to differentiate and the collection of memory colours can therefore be very different for different individuals. But the memory changes with time and the potential to develop a more discriminating colour vision is therefore substantial.

Despite such differences, the basic structure of the six main colours plus grey is considered relatively similar in people with normal colour vision, and this enables communication between people about the similarities and differences in colours of the world around them. According to FCM, no more than four different elements can vary at one time. This means that FCM allows for a simple notational system which can facilitate communication about nuances of colour. The maximum values at the poles and for neutral grey is 1.0. The sum of the constituent parts of the main colours or of neutral grey also has the value 1.0 for each colour nuance in the whole colour universe.

Thus maximum red has the value 1.0. A pure orange has the values 0.5 red and 0.5 yellow. Both these colours lie on the surface of FCM's colour sphere and are completely without greyness. Grey has a value of 1.0. A greyish orange has the values 0.5 grey, 0.25 red and 0.25 yellow. A whitish orange has the values 0.333 red, 0.333 yellow and 0.333 white. A weak, grey-white orange has the values 0.3 red, 0.3 yellow, 0.3 white and 0.1 grey. In the sequence of nuances from the surface of the globe to its inside, the proportion of each and every main colour reduces by the same amount that the proportion of grey increases. Every colour on the surface of any object can thus be determined with the desired degree of accuracy in relation to all the other colours in the colour universe.

The sun comes nearer to the horizon. The light grows increasingly redder, and in the street below my window, a woman's red coat shines with such an intense, shimmering red that the garment seems to lose all substance. The sun disappears and twilight extinguishes all colour. Even the highest cloud, which a while ago was coloured pink, becomes grey. Darkness falls. The colour model no longer applies. But then my gaze wanders inward, back to my store of memory colours – and there the sphere is turning still, helping me to structure and understand parts of the endlessly rich universe of colour which will again be visible tomorrow. Tomorrow.

Hans Fog, Professor