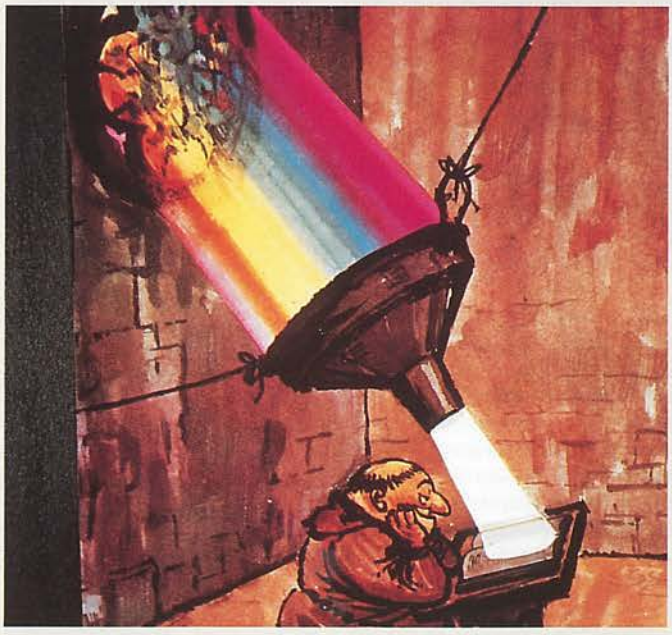
COLOUR - THE EXTRA DIMENSION

Of all the attributes of light, colour is probably the least understood. And yet colour is a vital element of visual information which determines the way we see objects.

This is easily demonstrated by our loss of visual information at night where illuminance levels can be very low. It is the subtle use of tints deployed in theatrical lighting which can be used, almost unseen, to convey emotions; warmth, coolness, fear and happiness. It works because colour is an essential part of the visual information that enables the brain to interpret what we see.

Early exploration of colour tended to seek an understanding of how we see and what in fact constitutes colour. Isaac Newton in his book "Optiks" published in 1704 drew attention to the comparison of white light, in particular how a prism could break a beam of white light up into its constituent colours – the well known rainbow effect. The colours have different wavelengths and are diffracted to different degrees; the red least, the blue most – forming the familiar spectrum. However, Newton did not actually offer an explanation as to how we see the colour.



It was Thomas Young in 1801 who first developed an explanation of how we see in colour from this three colour sensation and together with later work by Helmholtz the so called Young-Helmholtz Theory was established. This effect has been well used in theatre for acting area and cyclorama lighting using colour battens with individual colour dimming to create a variety of hues.

Within the eye there are some 100 million receptors at the back of the retina comprising "rods" which are particularly effective in night vision and "cones", concentrated mainly at the fovea which are activated by brighter light and responsible for colour vision.

There is a direct parallel with film. Colour film for example works on the basis of three layers of emulsion which in effect create red, blue and green photographs superimposed to give a richly coloured image. So, the three receptor theory in effect proposed the eye worked on a similar principle to film and TV. But does it? Because film and TV cameras react differently to the colour temperature of the light source. Lamps used in TV studios are carefully controlled to 3200 K and realistic pictures can only be obtained when used with daylight by the use of correction filters. Similarly for film; we have daylight and tungsten film, plus ranges of correction filters. It is necessary to correct for the colour temperature in which we are filming. But the eye doesn't see colours particularly differently despite variations in colour temperature. We seem to be able to adapt and yet if we only receive information from three colour receptors this should not be the case if our eye responds to the wavelengths coming from the objects we view. If this were so the colour we see would be constantly changing as the illuminance changes creating a range of hues, but it does not do this. Colour stays constant.

The use of colour for effect was exploited with great success in the theatre of the 1920's by Aidrian Samoiloff. Samoiloff used colour to create illusion. By changing the colour of light we choose to illuminate a painted scene we can dramatically change its appearance.

Anything red, lit with red light appears white – it has no colour. But lit with green light it turns black. Clever scenery painting could thus effect an instant scenic change simply by the use of coloured light. A summer scene could turn into winter or a country setting become a town. Make up plays its part as well. The instant costume changes of minstrel shows with blacked up faces and wearing spotted waistcoats and striped trousers, on a lighting cue would be transformed into full evening dress. How simply by a careful choice of costume design and make up, and what became known as the Samoiloff effect, using colour to elicit the very different visual response and convince the audience with illusion that it was the costumes that had been changed in front of their eyes.

Such use of colour can be explained by the Young-Helmholtz Theory. But then something else happened which eventually led to an explanation of some other colour effects used in theatre. In 1955 Dr Edwin H. Land, who in 1948 had invented the Polaroid camera, gave a demonstration that did not fit in with this theory. What he did was to produce the sensation of colour from a black and white picture. If there was no colour there in the first place to reflect colour wavelengths, how then did the eye see in colour?

When a black and white slide of an arrangement of some common objects is projected on to a screen we see only shades of grey-variations in intensity, but no clues to colours. If we now insert a red filter – we have the sensation of a rich colour scene. But this is not a colour slide. No colours are present.

In fact the Land Effect demonstrated that the eye could receive a sensation of colour from light received from a surface which itself contained no colour information; only that the two black and white photographs were taken one through a green filter and one through red.

A theory was thus evolved that rejected the view that it was wavelengths reflected to us that enable us to see in colour. Instead it was suggested different areas of the brain deal with different visual tasks. Colour is received by receptors and then decoded elsewhere. Form, the other key factor is dealt with by another part of the brain and this led to another series of experiments. Without other reference we do not see colour consistently. We are tricked. A theatrical illusion.

The experiments indicated that we do not work out colours from wavelengths coming to our eyes, otherwise colour would be constantly changing as illuminance changes. It proposed that colour of a surface is thus a property of the brain; not of the outside world. Colour and form are intricately linked. How we choose to unite or separate them determines the effects of illusions we can create.

Colour is perhaps an extra dimension that could be explored more fully in architectural applications as well. Not just splashes of primary colour, but a more subtle use to enhance the environment and contribute to the ambience created by intensity controls by conveying additional feelings of warmth or coolness. A range of equipment is now available to provide the lighting designer with the means to achieve these ambitions, from the Strand Minispot with a choice of dichrioic filters to remote colour changers used with theatrical spotlights to shape and form light or project patterns. ■