Color rendering on the computer screen and the printed page

White light, like that we get from the sun and from our indoor lighting, can be thought of as consisting of three components: red, green, and blue. All other colors are combinations of these three. Only when we experience equal amounts of all three simultaneously, do we interpret the light as white.

Computer and television monitors take advantage of this phenomenon by changing the intensity of three types of individual lights: red, green, and blue, each too small to be seen with the naked eye. When the red and green lights are on, we see yellow; when the blue and green lights are on, we see cyan; and when the red and blue lights are on, we see magenta. These combinations are tabulated below.

W = R + G + B

Y = R + G

C = G + B

M = R + B

From inspection of these formulae, it should be apparent that the three 2-color mixtures (yellow, cyan, and magenta) consist of white light minus one of its three components, as shown below:

W = R + G + B

W – B = R + G = Y

W – R = G + B = C

W – G = R + B = M

Color printers take advantage of this fact by using cyan, magenta, and yellow as inks to be mixed. The white paper on which the image is printed reflects all three components of white light, that is, red, green, and blue light. When yellow ink is placed on the paper, it subtracts the blue light from the white, and only red and green are reflected. Similarly, cyan ink subtracts the red, and magenta ink subtracts the green.

When two inks are mixed, each subtracts one of the three components of the white light, leaving only one component to be reflected to the reader's eye. For example, when yellow ink overlays cyan ink, the blue light is subtracted by the yellow ink, and the red light is subtracted by the cyan ink, leaving only green light to be reflected back to the reader. When yellow ink overlays magenta ink, the yellow ink subtracts the blue light, and the magenta ink subtracts the green light, leaving only red light to be reflected back to the reader. Similarly, when magenta ink overlays cyan ink, the magenta ink subtracts the green light, the cyan ink subtracts the red light, leaving only blue light to be reflected back to the reader. These are tabulated below:

W – B – R = G

W – B – G = R

W – G - R = B

Black occurs when no light gets back to the eye. On the computer screen this is accomplished by not turning on any of the little lights; on the page, this can be accomplished by overlaying all three inks (thereby subtracting each of the three components of white light). In practice, however, it is more efficient to use a separate, black ink for this purpose.