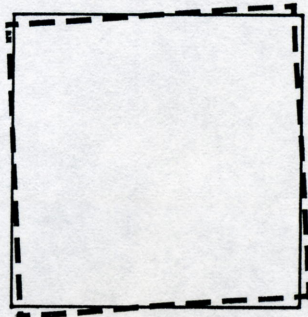
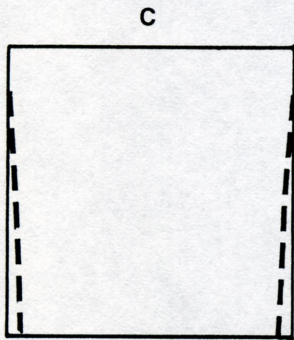


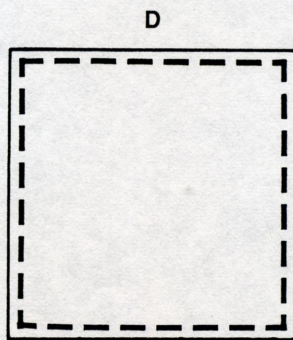
A



B



C



D

Figure 1. Some examples of simple two-color misregister. First-down color (the reference frame) is shown in solid outline, the second-down color in dashed outline. A is horizontal misregister, B is angular misregister, C is keystone misregister, and D is size misregister.

One expected cause was low color contrast. For example, in the good color register prints, the yellow printer could be in misregister more than 0.004 in. (0.10 mm). This also applied to inks with higher color contrast, such as magenta or black, where they appeared as light halftone tints. Apparently, their low color contrast made the effects of the misregister much less noticeable.

A less obvious cause was the effect of edge sharpness of the detail in the image. The sharper the edge—that is, the more abruptly the reflectance changed at the edges of detail—the more apparent a given amount of misregister was visible as a color fringe. For example, see Figure 2, which is a four-color reproduction of a color transparency. In making the transparency, the operator focused the camera lens on the center foreground object, making the background objects out of focus, with soft, diffuse edges. A given amount of misregister is more noticeable in the foreground object than in the background objects, since its sharper edges make the color fringing more apparent.

Misregister was most apparent in reverse type within a four-color process area. The sharp edges of the type and the high color contrast between the inks and the bare

paper give maximum visibility to any color fringing that is present.

In studying the above set of prints, we noted other factors that appeared to play some part in the appearance of color register for given amounts of misregister. One was the type of scene—whether its shadows were sharp or diffuse. Other factors, such as screen ruling, resolution, moiré patterns, and angle of misregister, also appeared to play some role in the appearance of color register. While more detailed studies of these factors would be desirable, the present study was limited to finding only the most general aspects of the relationship of color register to misregister.

For the prints in the test collection, it appeared that most of the overlap in the 0.004- to 0.007-in. (0.10- to 0.18-mm) misregister range was due to color contrast and edge sharpness in the detail. That is, greater misregister could be tolerated in low-contrast colors and soft-edged detail.

RELATIONSHIP OF COLOR REGISTER TO MISREGISTER

The above study indicated that if the misregister of any of the four process inks is held to less than 0.004 in. (0.10 mm), the color register will usually appear

satisfactory. Within a large group of observers, this value is expected to vary somewhat, depending on such factors as each observer's sharpness of vision and personal bias. However, it would be useful to know how the relationship of color register to misregister varied on each side of this value.

To get a measure of this relationship, a second random collection of commercially printed four-color process prints was assembled (2). The observer assigned each print a color register rating on a scale from 100 (perfect) to 0 (complete loss). A microscope micrometer was then used to measure the misregister in the central area of the halftone color image in each print. The measurement was taken between the two process inks having the maximum displacement from each other. Figure 3 is a smoothed curve representation of the relationship of color register rating to misregister for each print.

The curve reaches a rating of 95 for color register at a misregister of about 0.0035 in. (0.09 mm). No prints in the collection were given ratings higher than 95. Logical extension of the curve to a color register rating of 100 indicates a misregister of less than 0.003 in. (0.08 mm).

This limit is probably related to the limit of resolution of the eye that, depending on the method of measurement, is between 0.002 and 0.003 in. (0.05 and 0.08 mm) at a 14-in. (350-mm) viewing distance.

Going from left to right along this curve, for each 0.001-in. (0.025-mm) reduction in misregister, there are increasingly larger improvements in the rating for color register. For example, reducing the misregister by 0.002 in. (0.05 mm) in print with a color register rating of 57 increases the rating to 80.

This curve should be viewed with some caution, since no attempt was made to separate out the effect of factors known or believed to influence one's visual evaluation of color register. As mentioned earlier, factors such as color contrast and the edge sharpness of detail could affect the color register rating at a given amount of misregister. The curve has averaged out their effects in the sample print, and is only intended to show the approximate relationship between color register and misregister.