Appearance involves all aspects of visual experience by which things are recognized. These include form and markings as well as color and gloss. Color is the most important optical attribute of product appearance, and the one which shall be discussed in detail, but it should be remembered that gloss, luster, turbidity, haze, distinctness-of-image, reflection, texture and other attributes also play an important role.

Consumers have strong preferences for products which have appearances which appeal to them. Certainly, where there is a choice, the products with the greatest visual appeal will be chosen first. In fact, preferences for visual appeal and visual uniformity of appearance are economically so important that quantitative identifications of appearance, not mere subjective descriptions, must be demanded by businesses dealing with consumer products.

There have been seven different procedures described by R. S. Hunter for the identification of a product color:

1. by spectrophotometric curves (physical analysis);
2. by visually equivalent additive mixtures of red, green and blue;
3. by location in a three-dimensional color solid; for example: (a) CIE trilinear coefficients $x, y, \%Y$; and (b) opponent colors with gray in the center ($L, a, b, \text{or } U*V*W*$);
4. by densities of three subtractive-primary inks or dyes required to represent the color (color photography and color printing);
5. by location with respect to visually systematic arrangement of color chips (Munsell);
6. by location with respect to an array of chips of systematic subtractive mixtures, of white, black and colored pigments of each separate hue (Ostwald). These subtractive mixture dimensions of each color are familiar to the formulator or dyer who is experienced in obtaining product colors 'by eye';
7. by ingredients required to obtain the color in a given product: (a) derived by color formulator's estimates; (b) derived by optical model of product, optical constants of ingredients and a computer.

This discussion will be basically concerned with objective techniques within the general area of tristimulus colorimetry. Therefore techniques and problems in measurement will be limited to method (3).
When considering instrumentation used in tristimulus colorimetry one must consider what happens when light falls upon the object and also the non-optical characteristics of the object.

R. S. Hunter has pointed out:

that a number of things happen when light falls upon an object. First if the object is opaque, light will be reflected by it. If it is transparent or translucent, light will pass through the object, or be partially reflected or transmitted by the object primarily in one of two manners; specularly or diffusely. Specularly reflected light is that which (as with shiny objects) is concentrated in the mirror direction of reflection, as a continuation of the incident beam. The straight-through transmission of the light by a transparent object can also be thought of as specular, although this admittedly is taking some liberties with the literal meaning of the word. Diffusely reflected or transmitted light on the other hand, is that which leaves the object uniformly in all directions. Similarly, a white translucent film transmits light, uniformly in all directions; that is, the source of light is not recognizable through it as the source.

The foregoing analysis provides the basis for an arbitrary classification of objects into four groups, based on whichever of the four manners of light projection is dominant:

1. Opaque, non-metallic, such as a yellow ceramic vase.
2. Opaque, metallic, such as a metal bell.
3. Translucent, such as a plastic tumbler.
4. Transparent, such as a bottle of clear yellow liquid.

Reflecting objects fall in groups 1 or 2; transmitting objects in groups 3 or 4. Objects which reflect or transmit light primarily in a specular manner fall into groups 2 and 4. Groups 1 and 3 are made up of objects that reflect or transmit light in a diffusing manner.

Having established a very rough framework of optical groups it is necessary to briefly consider non-optical characteristics which affect measurement.

One of the simplest problems which arises when measuring a sample is the manner in which you place the cuvette for the sample itself on the instrument. This depends on the type of sample, i.e. whether it is a liquid or a solid, and the type of measurement you want to make. For instance, if a sample is a liquid, obviously it must be in a container. The container (cuvette) may then be placed on top of the aperture of the instrument and the light from the source will then pass through the bottom of the cuvette. Another method would be to place the cuvette in a vertical position with reference to the instrument. In this case, the light enters the sample through the side of the cuvette. When it is advantageous to view the sample directly and not have the light pass through the cuvette, it is possible on some instruments to invert the viewing head and view the sample from above. These three types of viewing may be seen in Figure 1.

Solids may be treated in the manner as liquids, but if they are compact and dry they can be placed directly on the viewing aperture. Another problem is caused by the irregularity of coloring in a food material. An example of an irregularly colored food is an apple which is partially red and partially green.

Depending on the size of each object in the sample, we can measure such a sample by either a spinning technique or a large area aperture. The concept of a spinning technique is illustrated in Figure 2. With large objects such as apples, a spinner to