

# A COMPUTER GRAPHICS SYSTEM FOR EXAMINING PAINT COLOR COLLECTIONS

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## ABSTRACT

A computer graphic program for organizing and displaying the colors in a paint collection is presented. A virtual representation for the traditional color card fan deck is described. This interactive program provides a lightness, chroma and hue interface for selecting a color from the collection. Software for visualizing a paint color on a three dimensional surface is also discussed. This tool allows the user to evaluate the sheen of a solid paint color and the travel of a metallic or pearlescent paint color.

**Keywords:** color, computer graphics, color selection, design, applied color science

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## INTRODUCTION

The traditional color card fan deck is still the primary tool that paint manufacturers employ to display their color collection to consumers. Although the cards may be presented individually on an elaborate exhibit within the paint store, the fan deck allows a person to hold the entire set in their hands and inspect the full array of choices with a single glance. For many years, customers in their homes, interior designers and architects in their offices, and painting contractors on the job site have used the fan deck to make color selections.

While every company attempts to put its own interpretation on how the colors are organized, each fan deck is usually arranged as a hue circuit. As can be seen in Figure 1, the colors on each card progress sequentially through the colors of the spectrum as one moves from the beginning to the end of the deck. However, for an individual card within the deck the change in color from chip to chip on that card is more complicated. Although there can be significant variations from manufacturer to manufacturer, on a single card one sees a tinting progression from dark to light for the hue shown on that card.



Fig 1. Fan decks and color cards from several paint manufacturers

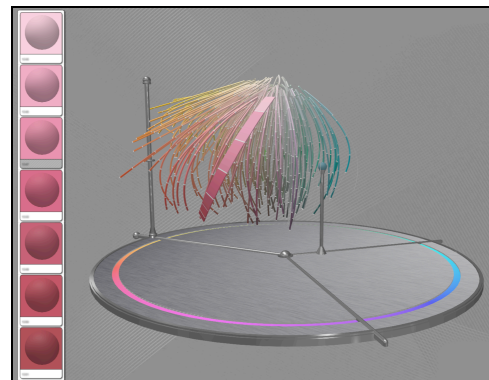


Fig 2. The Color Navigator with scanned sphere (large card under mouse)

While there is no written history of how color fan decks were designed, it appears that their organization was inspired by the paint mixing process and not by the color selection task. In many decks, the colors on each card are created by mixing only one or two colorants with the appropriate base white paint. While this makes it easier for the store clerk to correctly index the colorant carousel, it does not yield a system with traditional lightness, chroma, and hue (LCH) color dimensions and with perceptually uniform spacing between the colors. In addition to not providing an LCH designation for each color, the fan deck colors are only depicted in matte finish, and are only presented on flat chips. This makes it difficult for the consumer to appreciate the appearance of glossy solid colors and metallic or pearlescent effect paints.

In this paper we describe a computer graphics program that has been developed to overcome some of the limitations of the traditional color fan deck. We begin by showing how the Color Navigator portion of the program allows the user to select a color from the fan deck using an LCH interface. We then demonstrate the use of the 3D Color Viewer part of the program to evaluate different surface finishes for the selected color. Finally, we illustrate how a computer graphic rendering can help the user choose between a solid and a metallic color.

## COLOR SELECTION

### Scanning a Color Sample

A customer often begins with a particular color in mind. This may just be a concept but it may also take the form of a small physical example such as a swatch of fabric, a piece of wallpaper, a photograph, even a stuffed animal. Using a spectrophotometer attached to a computer this sample can be ‘scanned’ and converted to a value in CIE LCH color space. As our visualization is based on CIE LCH color space we can show the scanned color as a small sphere among the color strips representing the tints that are pre-formulated by the paint manufacturer

### Isolating a Color Region

Due to the large number of pre-formulated colors, the strips can appear quite crowded and can obscure the scanned color or the interior color cards (see Figure 2). We have provided a unique interface that helps the user isolate a particular region of color by eliminating the cards outside this region.

First, the full range of hue is unnecessary and detracts from properly inspecting the colors of interest. On the platform there are three handles extending from the center out to the edge. Two of these define a specific range of hue and can be opened or closed to control this range. By closing these down only a small wedge of hue remains visible. The third handle sits between the other two and will move the entire range to center on a different hue value when pulled. By manipulating these controls the user can begin to isolate their scanned sphere or the area of their color concept (see Figure 3a).

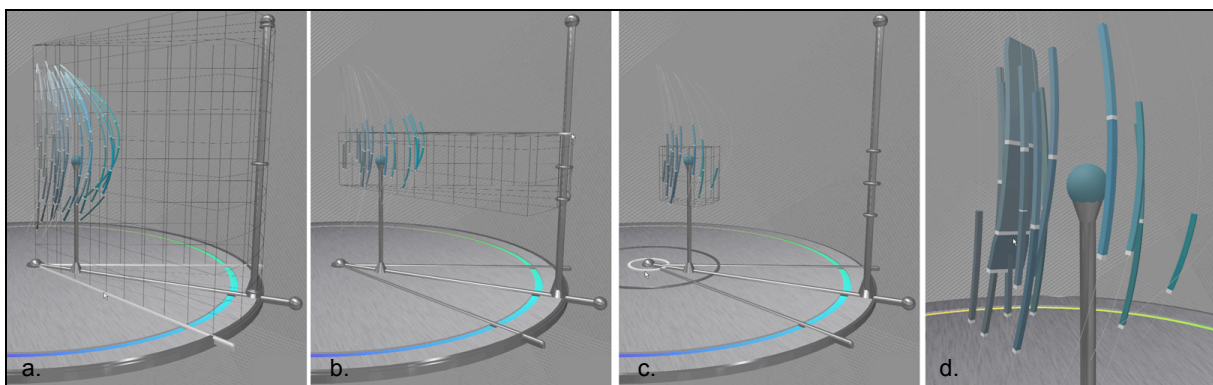


Fig 3. Limiting the navigator dimensions from Figure 2; left to right: hue, lightness, chroma, close-up.

Second, the color strips cover a wide range of the lightness dimension while again only a small portion of this dimension is close to the scanned color or concept. Rising out of the platform at the end of the central hue handle is a column that aligns with the L dimension. There are three rings on this column that operate similar to the three handles on the platform. By pulling the top and bottom rings the range of lightness can be limited. The central ring moves the entire range up and down the L dimension. By manipulating these rings the user further removes extraneous colors (see Figure 3b). When limited by lightness many of the color strips will be only partially outside the region. To accommodate this, the colors on a strip that are inside the limiting region are drawn as normal and those outside this region are represented with a small neutral line instead of a color chip. By this editing process the shape of the full color card is still visible while the clutter is greatly reduced.

Lastly, the color may be buried inside the space such that exterior color strips obscure the view while the dense interior area visually clutters the space. This can be alleviated with two more handles on the platform. Around the outside of the platform is a circle that can be pulled inward to eliminate exterior colors and limit the chroma dimension. A similar small circle near the center can be pulled out to remove the interior clutter (see Figure 3c). Now, only the color chips that are closest to the scanned color or the users color concept are visible while the rest have been filtered out. The full view of the platform is no longer necessary so the user may zoom in and re-center the visualization on this isolated area so that the color chips fill the larger part of the screen real-estate (see Figure 3d). Double-clicking a color adds it to the 'favorites palette' on the right, which is available in all of the different modules within our system.

## VISUALIZING PAINT REFLECTIVE PROPERTIES

With a small collection of potential colors built up the user can switch to a different module called the '3D Color Viewer'. In this mode, the user selects a 3D object on which to view their colors. The object is rendered with accurate reflection properties for the color specified.

### Gloss

Household paint is available in several gloss levels so, in addition to visualizing the basic color, our system also simulates gloss<sup>1</sup>. Understanding how gloss affects the appearance of an object is important for the customer and the paint selection process. Our system enables a natural, real-time exploration of this effect. For example, the object shown in Figure 4 contains subtle imperfections in its central curved medallion. When high gloss paint is used the boundaries between the imperfections

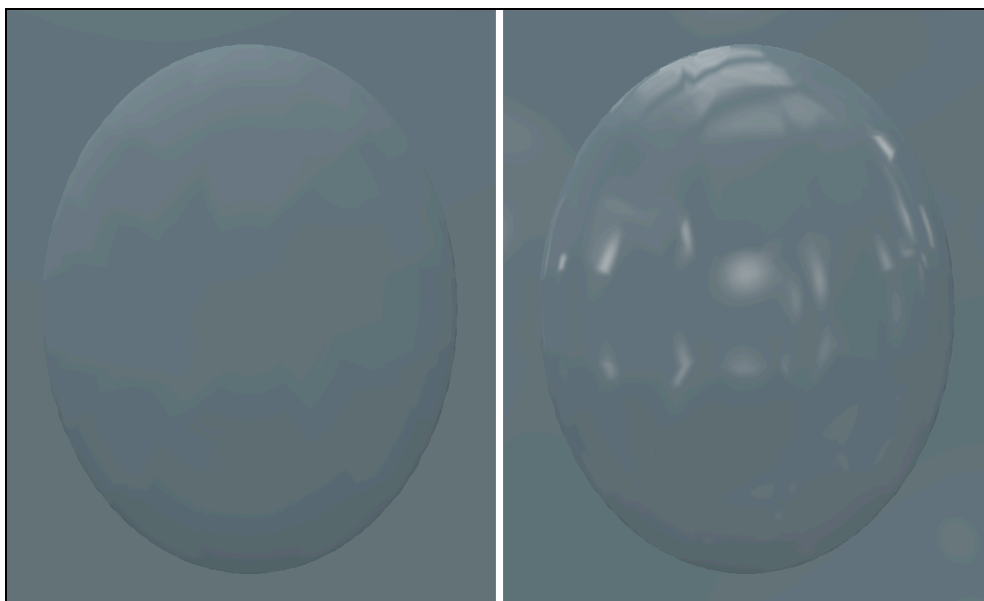


Fig 4. - Illustration of the visual effect of gloss (left matte finish, right high gloss finish).

become visible creating an effect that may not be desired. Matte paint disguises these boundaries giving a more uniform appearance across the central area.

### Metallic Reflective Properties

Our system is also capable of rendering metallic and pearlescent paint colors<sup>2</sup>. Metallic and pearlescent colors are fundamentally different from solid colors due to the inclusion of metal flakes or coated mica chips in the paint substrate. These particles cause a different color to appear at different viewing angles producing a ‘travel’ effect across the range of reflectance angles<sup>3,4</sup>. As with gloss, our system reproduces this view dependence in real-time creating the ability to examine how the metallic appearance can vary from object to object and to compare this with the appearance of a solid color. In Figures 5 and 6 we have selected a solid color on the left that closely matches the pearlescent color on the right. In Figure 5 we show both colors on a door containing many large flat areas. Notice the similarities between the solid and metallic versions. In Figure 6 we show both colors on a ceiling medallion containing curved relief detail and small repeating patterns. Notice the differences between solid and metallic in the presence of this detail.

### CONCLUSIONS

Computer graphics makes it possible to provide consumers with new methods to select paint colors. In this paper a novel interface was presented that allows the user to navigate through the color cards of a traditional fan deck. This program permits the user to quickly identify and examine all colors in the deck that are similar to an exemplar provided by the customer. The software also lets the user observe the color on a three-dimensional object, evaluate the effect of choosing a particular sheen for the color, and consider the possibility of using a metallic or pearlescent paint instead of a solid color. User studies are currently being conducted to quantify the effectiveness of these techniques.

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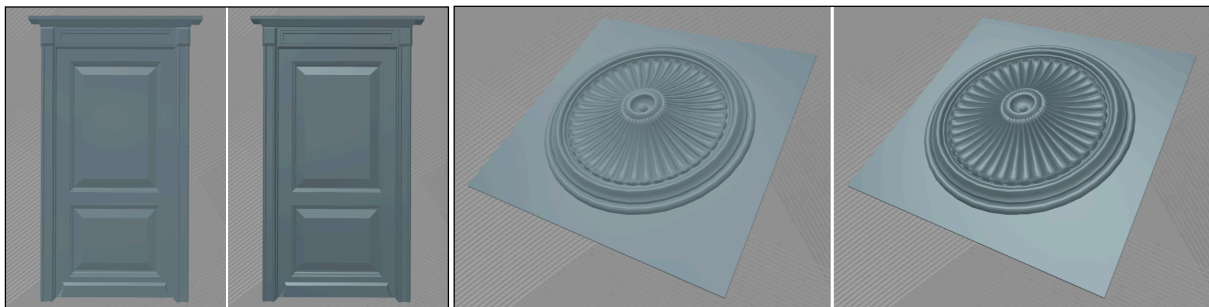


Fig 5. Solid color (left) vs. metallic color

Fig 6. Same colors as in fig. 5 on an object with more geometric detail