COLOR MAPPING

an interactive tool to explain and analyze color space

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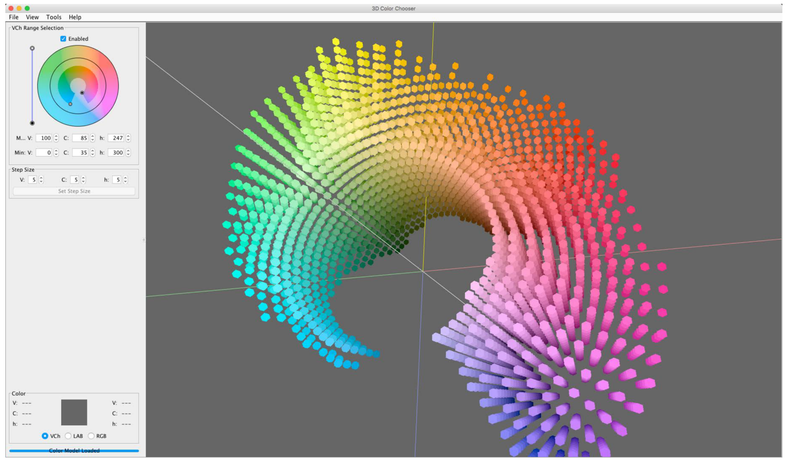
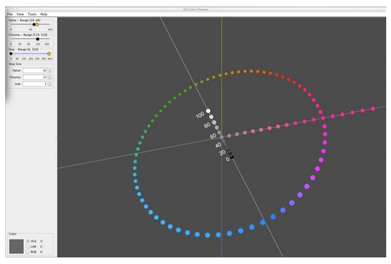
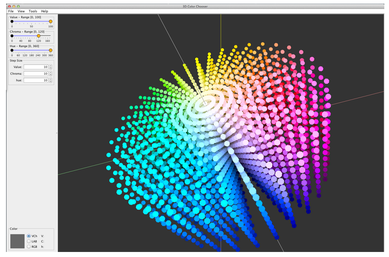
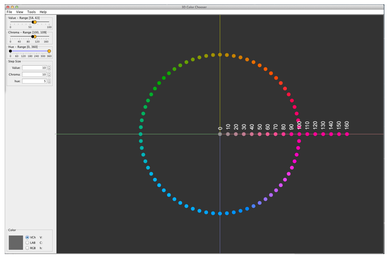
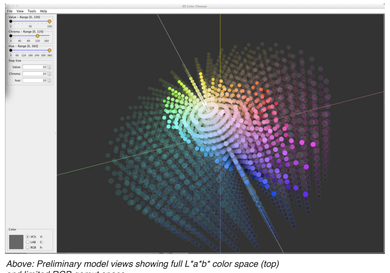


Above: Color space model with gamut limited to RGB.
With limited chorma 35-85, and limited hue 247-300, at a step value of 5 for VCH

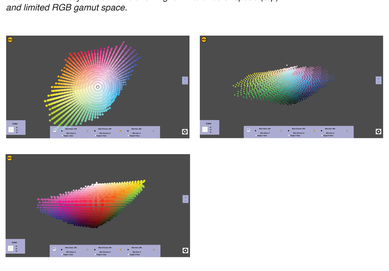








Above: Showing numerical identification for value (top) chroma (middle) and hue (bottom)



Above: Preliminary model views showing full L*a*b* color space (top) and limited RGB gamut space.

Although color is a concern of disciplines as diverse as art, science, business and medicine with applications ranging from the breakfast cereal industry to the Pentagon. Color is arguably one of the most misunderstood yet most used visual principles. The absence of a universal language accurately defining and articulating the essence of color science and color math serves to exacerbate confusion when discussing color.

Although the ability to create and view objects in virtual space (three-dimensions) has been readily available for decades, color systems are still being presented as two-dimensional or as two-dimensional depictions of three-dimensional models.

To better explain the complexities of color, we are developing an interactive three-dimensional software application capable of modeling and defining any color space in the universal language of mathematics. The software will allow for a comparison of multiple gamuts and can generate a 3D color map of any imported image or image sequence.

To understand color relationships, it is necessary to look beyond two-dimensional modeling. The VCU Color Mapping Project is a collaborative effort between art and physics faculty to create a three-dimensional color visualization tool. The software uses three parameters to display color location and relationships. To provide greater accuracy and specificity, the color-space identification system plots a color numerically on a Cylindrical Cartesian coordinate system, using percent (0 percent - 100 percent) to identify Value, a perpendicular scale (0-100+) to identify Chroma, and an angular rotating scale (0 degrees – 360 degrees) to identify Hue.

More than 100 years ago, Albert Munsell developed a method of quantifying color that was based on human color perception. He proposed the concept of identifying colors using a three-dimensional model. However, his system is limited since there are only 10 numerical steps for Value, nine for

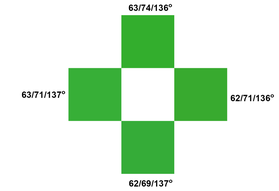
Chroma, and 40 for Hue to describe the many millions of colors that are perceptible with human vision.

We have a very limited vocabulary to describe the many million colors detectable with the human eye. When we use common names like red, blue and yellow to identify a color, we are referencing a very broad collection of colors and forcing each unique color into a larger group. We do this because we lack a common language to identify colors with greater specificity.

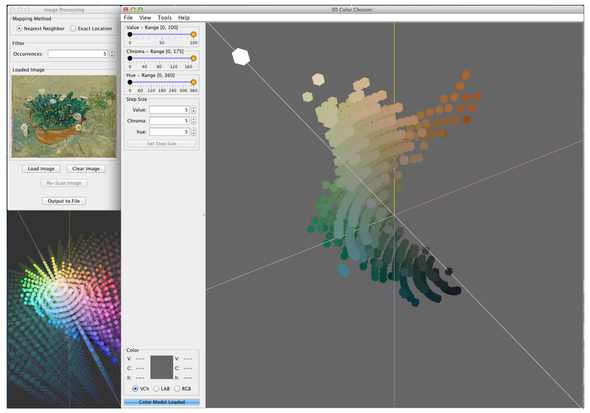
In professional practice, the tools used to identify, analyze and manipulate color can lack a level of precision and functionality that would benefit a range of fields where color analysis is important. Currently, graphic, interior and fashion designers and others who work with pigments use outmoded color pickers or rely on subjective judgments to select colors. They do this with little or no understanding of a color's location in a given color space. This lack of understanding may stem from the lack of a useable tool for color selection, quantification and visualization.

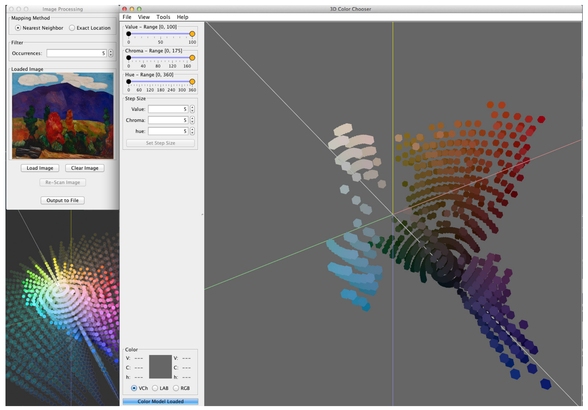
Any color modeling and analysis tool that attempts to go beyond a basic palette must also expand the vocabulary used to identify specific colors. There are simply not enough words to describe the many millions of colors visible to the human eye. Mathematics provide an unlimited range of specificity. Although most humans cannot distinguish a unit shift in Value, Chroma or Hue, mathematics yields an infinitely finer resolution. Math is a universal language, the number 10 is the same in English, French, Japanese and every other language.

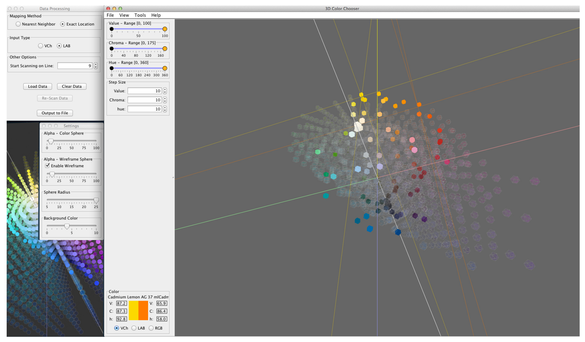
There are many very accurate color identification tools that can pinpoint a specific color and deliver the L*a*b*, RGB, and/or hexadecimal color location. The Mapping Color software we are developing can be used to identify a single isolated color and can also be used to map the color space for an entire image or image sequence.



While the untrained eye may see the squares above as being the same color, by using the VCH identifiers for each it is easy to tell which are the lightest, brightest and warmest.



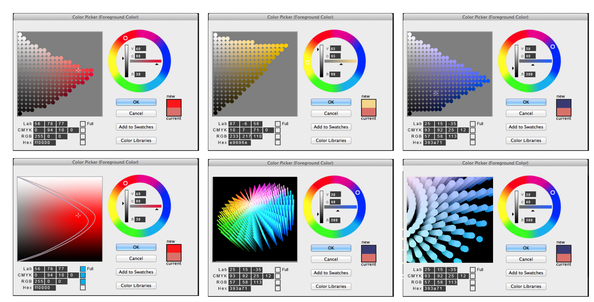




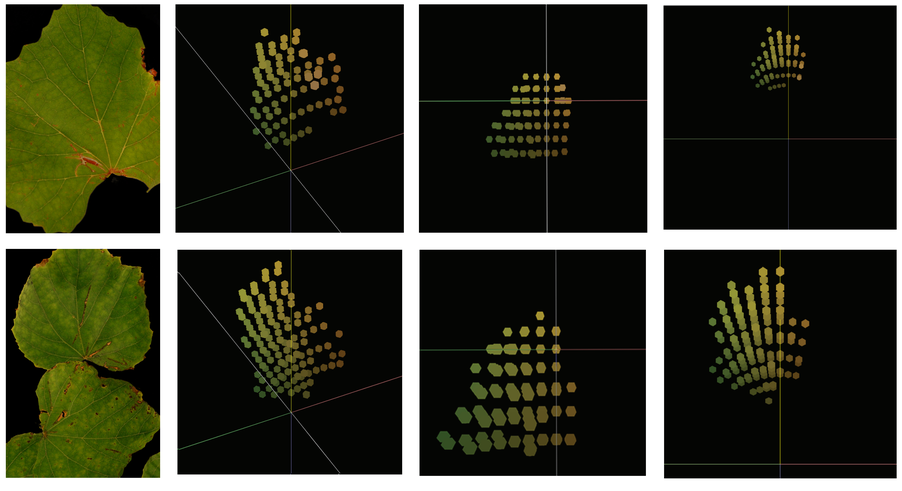
The above e diagrams compare the color space of "Daisy Aries" by Vincent Van Gogh (above left) and "Franconia Notch" by Marsden Hartley (above)

Similar analysis could be use on the same painting over time to show color deterioration.

Right: 3D location of all the colors in the Gamblin oil color set



Above: diagrams showing a universal, digital color picker that is based on 3D VCH model.



Right: Working with the VCU Department of Biology the Mapping Color team was asked to analyze the color of leaves and to determine if the color tool developed for the project could be use to detect the presence of buried land minds.