



## 3-D Glasses Kit

P3-6100-01

### BACKGROUND:

ChromaDepth™ 3-D is the most versatile 3-D image method available. This new process allows spectacular 3-D images to be created and presented in print, film, video, television, computer graphic, and laser show formats. Creating exciting ChromaDepth™ 3-D images is most easily accomplished when the artist has an understanding of the functions of both 3-D glasses created with the ChromaDepth™ 3-D technology and the ChromaDepth™ 3-D depth encoding process.

The patented ChromaDepth™ 3-D process enables the creation of “normal” looking color images that can be viewed as two dimensional images without ChromaDepth™ 3-D glasses, but which jump into dramatic 3-D when viewed through 3-D glasses created with ChromaDepth™ 3-D technology. The ChromaDepth™ 3-D process is entirely new, but to understand how it works we need to first discuss the old 3-D methods.

When you see an image in 3-D both your left and right eyes see slightly different images from each other. The differences in these two images, called a stereo pair, conveys depth information to your brain. If you remember the old 3-D comics, you will recall that the pictures consisted of two overlapping line drawings printed in red and blue. The red and blue glasses that came with the comic (if you were lucky) allowed only one image through to each eye, thus making a stereo pair. The red and blue glasses 3-D method is called anaglyph 3-D.

3-D glasses created with ChromaDepth™ 3-D technology are completely clear, unlike the anaglyph 3-D glasses. Although they look simply like clear plastic, each of the lenses in the ChromaDepth™ 3-D glasses actually incorporate a high precision system of micro-optics which creates a stereo pair from a single image. The lenses accomplish this by shifting the image colors in different directions for each eye. The concept of ChromaDepth™ 3-D is straight-forward; encode depth into an image by means of color, then decode the color by means of optics, producing a true, stereoscopic, three dimensional image.

Since color is used to represent depth information, the depth encoded image is a single image. Depending on the subject matter and the skill of the image creator, the effect of the ChromaDepth™ 3-D depth encoding may be to make the image look completely artificial, like a fantasy computer graphic, or to look completely natural. Lovely examples of completely natural-looking ChromaDepth™

TM 3-D images can be found in almost any book of underwater reef photography. The natural colors of this world often fall accidentally into exactly the right depth encoding to make the image beautifully 3-D when viewed with 3-D glasses created with ChromaDepth TM 3-D technology.

There is a wide range of variation possible with ChromaDepth TM 3-D. The glasses optics come in four different varieties and the depth-to-color relationship (the ChromaDepth TM 3-D mapping) depends on the choice of background color. For the purpose of this document, we will assume that the 3-D glasses created with ChromaDepth TM 3-D technology are red proud (meaning that red is the foreground color when placed on a black background) and that a black or dark blue background will be used. This combination leads to the most natural looking images, and it has the most consistent set of design rules.

## BACKGROUND COLOR:

The choice of background color is the most important factor in determining the colors which should be used to achieve ChromaDepth TM 3-D effects. The easiest and most commonly utilized background colors are black and dark blue; the same set of ChromaDepth TM 3-D colors apply to both of these background colors. If dark blue is used, it must be a very pure, very dark blue, not a sky blue, medium blue, or other lighter-than-dark-blue. The reasons for this are explained in the section on **Tint and Depth Position**.

If a dark blue background is used it is important to incorporate some black pattern on the blue in order to locate the background in depth space. Without a black pattern the blue background seems to be undefined space; it occupies some nebulous 'back there'. The black pattern provides edges for your mind to locate in space, enlarging the apparent depth. For more on the use of black and the importance of creating edges, see the section on **Use of Black**.

On a black or dark blue background the ChromaDepth TM 3-D color palette uses red for the most foreground object, dark blue for the most back-ground object, and green for the middle ground. The other colors fall in between according to the colors of the rainbow. (Thus one could use red, orange, yellow, yellow-green, green, blue-green, blue, and dark blue, in order, from foreground to background). An infinite number of colors may be used to divide the space between red and blue, contoured surfaces can be shown by smoothly grading, or blending, from one color to another across the surface. Be sure to use black patterns on the surface to help define its shape; see **Use of Black** for details.

If a white background is chosen the ChromaDepth TM 3-D color palette is the compliment of the color order for a black background. This makes the key colors cyan, magenta, and yellow (CMY; the compliments of red, green, and blue, respectively). The inverse color function on many computer graphic design programs can take a normal black background ChromaDepth TM 3-D colored image and convert it to a white background, CMY ChromaDepth TM 3-D image.

Blue be warned; although the depth effect works about the same, the images thus created look extremely unnatural. The ChromaDepth TM 3-D color palette for a black background follows the colors of nature and of normal artistic design, but the white background CMY color palette looks positively bizarre. Then again, that may be just what you want....

## DEPTH CUEING:

Using normal two dimensional depth cues in an image can dramatically augment the depth created by the glasses. These included shading for roundness, perspective and forced perspective effects, overlap, changing size as depth is changed, including shadows of one object on another, and increasing the brightness of colors as objects are brought closer to the foreground.

It isn't always necessary to change the color of an object as it is moved in depth space. An object moving from the background to the foreground can increase in size as it moves up the color palette from blue through green, yellow, orange, and red.

Once it is red, it can remain that color while it continues to move forward and increase in size. Even though the ChromaDepth™ 3-D color is not changing, the strong depth cue of size increase continues to fool your brain into seeing the object move forward. Similarly, moving an object back through the colors to blue while shrinking it will make it appear to recede in the distance, and the shrinking can continue after the object has reached maximum blue.

With strong enough two dimensional depth cues it is even possible to keep the sense of real stereoscopic depth while mixing up the colors, such as placing an orange object behind a yellow one by use of perspective and shadows. This does not always work, so be careful and don't try to push it too far.

## AVOIDING THE IMAGE BORDER:

The border of an image generally appears to be at the middle ground position. Any object colored to appear at middle ground or deeper can be clipped by the border without any visual problem; it looks like the border is a frame above the object, like it is in a shadow box.

Any object that is colored to appear closer than middle ground should be kept away from the border because it will appear to snap down to the border where it touches it, losing the depth effect (incidentally, this is true for all 3-D processes, not just ChromaDepth™ 3-D). Adding a red or black border around the image can reduce this problem. In a moving image a red object can move off-screen across the border if it does so quickly; your mind doesn't have time to figure out that it should have snapped back to the border.

## HIGHLIGHTS:

In two-dimensional art, highlights from shiny surfaces are normally shown by a white spot or white starburst. This causes a problem for ChromaDepth™ 3-D images because the color white tends to the middle ground of the image. This means that a white highlight on a blue object will look like it is floating off of that surface, while a white highlight on a red surface will look like a bright point inside of the red surface. Highlights can be used with ChromaDepth™ 3-D; they just aren't white.

There are two main methods for showing highlights, and they can be combined in different amounts according to taste. The first approach is to select the highlight color to be slightly closer than the surface it is on.

Here is how it works: the highlight on a surface should be just slightly closer than the surface, so it is necessary to use highlights which follow the ChromaDepth™ 3-D color/depth palette.

We have found that using a color which is five (5) percent closer (closer means "towards red") than the highlighted surface is quite effective. For example, if the scene has been divided into twenty depth zones, a five (5) percent closer highlight would use the color of the next closest depth zone. For one hundred (100) depth zones you would move closer by five (5) depth zones for the highlight.

The second method is to keep the color the same as the surface, but to increase the brightness. This works well for TV and video, since the main object colors need to be slightly muted (by adding black to shade them down) to keep them 'NTSC legal'. NTSC illegal colors 'bloom' on the screen, blurring past their intended boundaries.

This is fine for a highlight, so using NTSC illegal color brightnesses for highlights works well to emphasize the extra brightness of the highlight.

With a little imagination, these approaches can be combined.

## USE OF BLACK

Black is extremely useful to the ChromaDepth TM 3-D artist. We say that 'black rides with the color it is on'. Put a black spot on a red area, and that black is at the same forward depth position as red; put a black spot on a blue area and that black spot is in the background with blue.

Wherever possible, black should be used to outline colors which are on a black or dark blue background. In a similar manner, white should be used to outline colors against a white background.

When our brains compare the differences in the images of a stereo pair in order to determine what depth should be perceived, it is the edges of objects and other high contrast vertical features which are compared. If you want to blend colors across a surface to show roundness or bending, it is very effective to add some black lines into the surface to provide the edges that convey the depth. For example, if you want to show a ball that has roundness, you can blend from red at the closest point around to yellow at the edge, then add black shading or cross-hatching lines as would normally be used to indicate roundness in a two dimensional image. If the weight, or thickness, of these black lines is adequate, the lines will allow your mind to see the height differences by the color blending in a very effective manner. (Very fine black lines may blur and disappear when viewed with the ChromaDepth TM 3-D glasses).

## TINT AND DEPTH POSITION:

When we speak of tint we are referring to taking a pure color and adding white to it. The resulting lightened color is a tint of the original. Tints can be used to broaden the range of colors which appear to lie at a given depth position and to give textured effects to surfaces. Here is the lowdown:

We will first presume that we are working with a black or dark blue background. Under these circumstances a white object will appear to be in the middle ground position, about equally spaced between the foreground and the background. Adding white to any color 'pulls' that color toward the middle ground. The degree to which the color is moved toward middle ground depends on the amount of white added to it. A little white only moves the color a little, much white moves it far. Since the colors are pulled toward the middle ground, each color reacts to tinting in its own way. Reds and oranges move further away, since they are forward of middle ground. Yellow and yellow-green don't move much since they are already about at middle ground. Greens and blues move forward with tinting, since they are behind middle ground. All colors end up at middle ground as they are tinted completely to white.

An extremely effective use of tint is to add texture to a dark blue background by tinting areas to show raised portions. A surprisingly small amount of added white will result in a definite and pleasing depth change for blue. Don't forget to include some black in such a pattern to help define the location of the darkest blue.

## SHADING AND DEPTH POSITION:

Shading a color by adding black tends to move that color back, regardless of whether it is a foreground color or a background color. The reason probably depends on the use of shadowing to show roundness as a two dimensional depth cue. If a color is shaded those surroundings; i.e. the more black added to a color, the more the surroundings of the color will determine its location and the less it's own hue will matter.

## COLOR QUICKS:

Red on yellow, with no black border between them, has an ambiguous depth position. It tends to look like the red is inside of the yellow area, down about at middle ground. A black border restores the colors to their expected positions. Red on green can have the same trouble as red on yellow if there is no black border separating them. The controlling factor is the brightness of the green. A bright green will behave more like yellow, a dark green will behave more like blue.

Red on dark blue works without a black border. Light blue, or other light color tints, can behave like yellow, so use a black border whenever there is any question. Magenta on black typically looks like a crisp, red object surrounded by a fuzzy blue halo. We don't recommend magenta unless you are seeking that kind of effect.

## READABLE TEXT:

Black on white is the normal choice for text, but this combination is singularly difficult to read when using ChromaDepth™ 3-D glasses. We recommend any of the following six color combinations for good readability:

1. Red text on black background.
2. Black text on a red background (orange might work, too; check out your particular color)
3. Magenta on white
4. Cyan on white
5. White on magenta
6. Magenta on cyan.

If none of these please you, resort to the best design method of all:

EXPERIMENT!





## 3-D Glasses

P3-6100

### BACKGROUND:

The 3-D glasses contain two diffraction gratings. These gratings act like prisms and shift light waves at different angles depending on their frequency (or color.) They are more heavily weighted for certain colors than for others. If you are looking at a colorful image on a 2-D surface, then your eyes have to focus in on each color at different angles. The glasses trick your eyes into focusing in on red as if it were closer and blue as if it were further away. All other colors are staggered in between.

### ACTIVITIES:

1. View any brightly colored material with the glasses on. Also, try viewing computer graphics and even television shows. Discuss the difference between colors and frequency. Introduce the notion that different colors shift at different angles.
2. You and your students can produce your own artwork to view. Use colored markers and a black marker for outlines. Remember that red is always closest and blue is always furthest away. The rest of the spectrum is staggered between. Experiment with different techniques, such as color blending, black and white out lining, and surrounding colors with other colors. Computer graphics with animation can capture the essence of the 3-D glasses.