Color Wheel and Gradient Slider Boopsi Classes

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The Color Wheel and Gradient Slider classes are V39 additions to Boopsi. They are intended for use with the expanded color capabilities of the Advanced Graphics Architecture™ (AGA), but are backwards compatible with ECS. In order to understand their use and the reasons they were added, a brief background on color theory follows.

The color model in Amiga systems from V30 (Release 1.0) through V38 (Release 2.1) has been RGB based, that is, color was specified as some combination of red, green and blue. These are known as the primary additive colors. If you start at a value of zero for each primary--the color black--adding varying levels of them enables you to specify any of the Amiga's colors till you've added them all at their highest level which is the color white.

The opposite of the primary additive colors are the subtractive primary colors, cyan, magenta, and yellow, respectively. These colors are created by completely subtracting one of the primary colors from white. Cyan is green-blue, magenta is red-blue, and yellow is red-green. Subtracting all of them brings you back to the color black.

Another method of specifying colors is in terms of hue, saturation and brightness, HSB. Hue is the dominant wavelength in the light we receive; we associate color names with hue. Saturation is a measure of the purity of the dominant wavelength, that is, the more dominant the wavelength, the more pure or saturated it is. Brightness is a measure of the luminance or brilliance of the wavelength.

The RGB method of color specification is used because it corresponds to the red, green and blue receptor cones in our eyes. Through the varying intensities of these wavelengths that the receptors receive, we are able to see colors. It's a natural way for us to represent colors and till now, was the only OS-supported way on the Amiga. Some applications did allow users to specify colors in terms of HSV (V stands for value and corresponds to brightness), but the HSV calculations had to be done by the application.

Under V39 (Release 3.0), the color model includes both RGB and HSB. It also expands from a twelve bit color definition--four bits each for red, green and blue--to a twenty-five bit color definition - eight bits each for red, green and blue plus one bit for genlocking. With the expanded color model, programmers and users have finer control over color selection than ever before.

The new color model is based on a color cylinder where the set of available hues, saturations and brightnesses is represented as a cylinder. The cylinder is divided radially into hues, with the saturation level of a hue increasing from zero at the center of the cylinder to its maximum at the outer edge of the cylinder. The altitude of the cylinder represents the brightness of the hue. At the top of the cylinder, the brightness is maximized; at the bottom, the brightness is minimized. We see the minimum brightness as black, regardless of the hue; the maximum brightness of a hue, however, is not white.

If you refer to color theory literature, you will notice the V39 color model closely resembles the Munsell color model. The similarity is not by design, but makes for interesting reading nonetheless.

To implement the new color model, V39 adds two new Boopsi classes, the Color Wheel and Gradient Slider classes. The classes provide two gadgets for use with palettes: the color wheel and gradient slider gadgets. The color wheel gadget is a two dimensional representation of the hue and saturation elements of the cylinder called a color wheel. The gradient slider gadget is based on the brightness element of the color cylinder.

Visually, the color wheel gadget is a display of all of the available hues and their saturations depicted as a multicolored wheel with a selector knob that can be moved anywhere on the wheel. The gradient slider is typically a vertically oriented slider displaying a smooth transition of a color from its brightest to its darkest. The gradient slider knob selects the intensity of the brightness.

This is a huge change in how a user selects colors. The old method was to display a color in an indicator box with three sliders for the red, green and blue components of the color and each slider's knob set at the proper level of the components. The user would then select the desired color by manipulating the three sliders.

With the color wheel gadget, the user can move the knob to the approximate color he wishes to use, and then, if sliders are provided as they are in the V39 Palette Preferences editor, manipulate the sliders to refine the components of the selected color.

In the same way that the color wheel knob can be moved to the approximate color, the gradient slider gadget knob can be moved to the approximate brightness level. The color wheel and gradient slider gadgets provide a much more intuitive method for selecting colors.

For developers, the new gadgets do the heavy lifting like all Boopsi gadgets. As the user moves the mouse across the color wheel, the gadget will return the RGB or HSB value (depending on which you request) corresponding to the knob location, and the gradient slider will return the current position of the knob as a value between the highest brightness value and the lowest brightness value. In addition, the color wheel has two functions that convert RGB values to HSB and vice versa.

Intuition vs. Graphic Pens

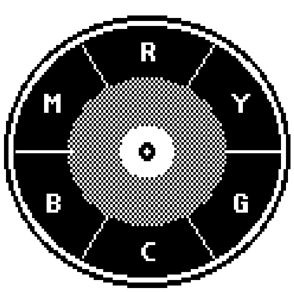
Under Intuition, the term ‘‘pens’’ refers to the colors used to draw pieces of screens, windows, menus and text. You specify a longword value for an Intuition pen (e.g., DETAILPEN pen is the logical name for the color of the text in the screen’s title bar) and the system does the rest.

In the graphics.library, the term ‘‘pens’’ can refer to *any* color, you are not limited to the Intuition logical names. A single pen maps to a single color register and a color register consists of 24 bits of color plus one bit for genlocking. However, when you get, load, or set a color register’s RGB value using the V39 functions, you always work with them as 32-bit values.

An easy way to think of pens is as indices into a colortable that is three times the number of registers. Pen 0 is the combination of colortable entries 0, 1, and 2; Pen 15 is the combination of colortable entries 45, 46, and 47.

The Color Wheel Gadget

The color wheel gadget has two rendering modes of display: monochrome and color. The rendering mode is dependent on the number of bitplanes its screen has, and the number of available pens.



The Monochrome Color Wheel

One or two bitplane screens result in a monochrome wheel; if there are enough pens available, you will get a minimal color wheel with three or four bitplanes. Five through eight bitplane screens result in successively more colors as the bitplanes increase. The V39 Palette Preferences editor, for example, uses eight bitplanes when available to render the best looking color wheel possible.

The monochrome rendering mode exists for instances where the color wheel is being used on an ECS system and there aren’t enough pens available, or when the color wheel screen cannot get four bitplanes. If you are using an ECS machine, you can be fairly certain of getting a minimal color wheel if you limit the gradient slider pen array to four pens.

A monochrome color wheel is broken into six sectors, one each for the additive and subtractive primaries. The sectors are denoted by the first letter of its associated primary.

You can localize the sector markers by using the `WHEEL_Abbrv` tag. The default string is "GCBMRY." Make sure your localized tag is in the proper order.

The color wheel gadget can handle both RGB and HSB 32-bit values. This enables developers and users to work with it in either mode. When you create the color wheel, the RGB or HSB values you set determine the initial position of the knob. These values default if you do not supply them. The RGB defaults are full red, no green, no blue; the HSB defaults are hue 0, full saturation, full brightness. The default knob position is, accordingly, the topmost edge of the red section of the color wheel.

RGB and HSB values can be passed to the gadget either as separate tag items, or in an RGB or HSB structure. The tags and the structures are defined in *<gadgets/colorwheel.h>*.

Tag Name	Purpose
`WHEEL_Hue`	set the hue component
`WHEEL_Saturation`	set the saturation component
`WHEEL_Brightness`	set the brightness component
`WHEEL_HSB`	set HSB using an HSB structure
`WHEEL_Red`	set the red component
`WHEEL_Green`	set the green component
`WHEEL_Blue`	set the blue component
`WHEEL_RGB`	set RGB using an RGB structure

```
struct ColorWheelHSB
    {
        ULONG cw_Hue;
        ULONG cw_Saturation;
        ULONG cw_Brightness;
    };

struct ColorWheelRGB
    {
        ULONG cw_Red;
        ULONG cw_Green;
        ULONG cw_Blue;
    };
```

Keep in mind that although you can specify brightness, it will not be displayed because the colorwheel's two dimensions are hue and saturation. Instead, the colorwheel gadget can pass this value to the gradient slider gadget if you set the `WHEEL_GradientSlider` tag with the address of the gradient slider. Then, any time the wheel brightness is modified, the slider knob position will automatically display the change.

The color wheel will return either RGB or HSB values depending on how you query it. If you wish to continuously receive mouse position reports as the user moves the knob, set the `GA_FollowMouse` tag when you create it.

The Gradient Slider Gadget

The gradient slider gadget is a non-proportional gadget for the brightness component of a color. It has a special attribute--it can render a pen array as a color gradient in its box. If you properly specify the pen array, the gradient slider will render it as a smooth transition, most times from brightest to darkest, although you may choose to go from darkest to brightest. The intent of the gradient is to allow the user to move the knob to the appropriate brightness level of the selected color.

The position of the gradient slider knob is set by the value of the `GRAD_CurrVal` tag. However, there are two potential pitfalls that you must take into account when setting this tag. The first is that the top of the slider is zero and the bottom of the slider is the largest value in its range. This is the opposite of what you would expect. The other is that the gradient slider works with 16-bit values, not 32-bit like the color wheel. Make sure you account for these.

If you modify the brightness of the color wheel, the gradient slider will pick up the change via the link established by the color wheel's `WHEEL_GradientSlider` tag. The gradient slider converts the 32-bit brightness value to a 16-bit value and sets the knob position to the proper position.

Creating the Pen Array

The pen array you pass to the gradient slider is a set of pen numbers you obtain using the V39 ObtainPen() function, or from an existing set of pens like the screen's pens. In most cases, you will use the ObtainPen() function.

Before you create the pen array, you need to decide where you will begin. You have two choices, you can use a color from the current palette or design a color of your own. In the former case, you access the color registers of the screen's colormap; in the latter case, you set the RGB or HSB values yourself. In this article, color 0 (color register 0) of the screen's palette will be used.

To access a colormap's registers, you call the V39 function GetRGB32(), passing it the colormap, the starting color register, the number of registers and an array large enough to hold three times the number of registers you request. As was stated above, a color register consists of the combination of three colortable entries; GetRGB32() returns three 32-bit values for every register you request.

```
ULONG colortable[12];  /* space for the first four colors */
struct Screen *Colorscreen;

/* Get the first four colors */
GetRGB32(Colorscreen->ViewPort.ColorMap,0L,4L,colortable);
```

Once you decide which color to use, the RGB values must be converted to HSB values in order to modify the brightness. You do this with the color wheel function ConvertRGBToHSB() which converts the RGB values stored in a ColorWheelRGB structure to HSB values and returns them in a ColorWheelHSB structure.

```
struct ColorWheelRGB rgb;
struct ColorWheelHSB hsb;

/* set RGB values for color 0 in ColorWheelRGB structure */
rgb.cw_Red   = colortable[0];
rgb.cw_Green = colortable[1];
rgb.cw_Blue  = colortable[2];

/* now convert the RGB values to HSB */
ConvertRGBToHSB(&rgb,&hsb);
```

Since the topmost color is going to be the brightest, its brightness must be set to the maximum value, $FFFFFFFF.

```
/* max out the brightness component */
hsb.cw_Brightness = 0xffffffff;
```

The final decision is the number of pens to use to render the gradient. A good rule of thumb is eight pens as a minimum and sixteen as a maximum. Eight will give you a nice display and sixteen will give you a very nice display. If you’re wondering, the Palette Preferences editor uses as many as thirty-two pens.

With the starting color converted to HSB, its brightness maximized and the number of pens set, the pen array can be built by converting each new HSB value back to RGB with the ConvertHSBToRGB() function and calling ObtainPen(). Remember, member 0 of the array will be the starting color and each successive member will be proportionately dimmer. To facilitate updating the pen array later on, a structure for use with the V39 LoadRGB32() function is set up for each pen number. The code below demonstrates how the array is built.

```
#define GRADCOLORS   16       /* Set to 4 for ECS to ensure enough color wheel pens */
struct load32 color_list[GRADCOLORS + 1];
WORD penns[GRADCOLORS +1];
WORD numPens;

numPens = 0;
while (numPens < GRADCOLORS)
{
    hsb.cw_Brightness = 0xffffffff - ((0xffffffff / GRADCOLORS) * numPens);
    ConvertHSBToRGB(&hsb,&rgb);

    penns[numPens] = ObtainPen(Myscreen->ViewPort.ColorMap,-1,
                     rgb.cw_Red,rgb.cw_Green,rgb.cw_Blue,PEN_EXCLUSIVE);
    if (penns[numPens] == -1)
        break;

    /* Set up LoadRGB32() structure for this pen */
```

```
        color_list[numPens].l32_len = 1;
        color_list[numPens].l32_pen = penns[numPens];
        numPens++;
    }
    penns[numPens] = ~0;
    color_list[numPens].l32_len = 0;
```

The pen array is now complete and ready to be passed to the gradient slider when you create it.

Updating The Pen Array

In our scheme, we said the color gradient is updated every time the user moves the mouse to a new position on the color wheel. This is done by updating the pen array whenever a mousemove message is received.

The algorithm is to query the color wheel for the current HSB setting and then loop through all the pens as we did above to gradually decrease the brightness. There is one difference, though, instead of obtaining pens, we will change the colors of the pens using either SetRGB32() or LoadRGB32(), both of which were added for V39.

If you use SetRGB32(), you must call it for each pen you change; if you use LoadRGB32(), you can pass it a structure containing a variable number of pens to change in one call. As we said, we will use LoadRGB32().

```
    case IDCMP_MOUSEMOVE:

       /*
        * Change gradient slider color each time
        * colorwheel knob is moved.  This is one
        * method you can use.
        */

       /* Query the colorwheel */
       GetAttr(WHEEL_HSB,colwheel,(ULONG *)&hsb);

       i = 0;

       while (i < numPens)
       {
           hsb.cw_Brightness = 0xffffffff - ((0xffffffff / numPens) * i);
           ConvertHSBToRGB(&hsb,&rgb);

           color_list[i].l32_red = rgb.cw_Red;
           color_list[i].l32_grn = rgb.cw_Green;
           color_list[i].l32_blu = rgb.cw_Blue;
           i++;
       }
       LoadRGB32(&Myscreen->ViewPort,(ULONG *)color_list);
       break;
```

Using the Gadgets

The color wheel and gradient slider gadgets are found on the system in the Classes/Gadgets drawer of Workbench as *colorwheel.gadget* and *gradientslider.gadget* instead of being part of Intuition. They must be opened with OpenLibrary() before they can be used.

```
struct Library *ColorWheelBase, *GradientSliderBase;

main()
{
...

OpenLibrary("Gadgets/colorwheel.gadget",39L);
OpenLibrary("Gadgets/gradientslider.gadget",39L);
```

Once opened, you use them as you would any Boopsi gadgets, that is, create them using NewObject() and dispose of them using DisposeObject(). However, you must use CloseLibrary() because you used OpenLibrary() earlier.

```
CloseLibrary(ColorWheelBase);
CloseLibrary(GradientSliderBase);
```

The example program below creates a color wheel and gradient slider on the deepest screen possible. As you move the color wheel knob around the wheel, it will update the gradient of the gradient slider.