

The Complete Reference



Chapter 13

Color

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Colors are used on the Web not only to make sites more interesting to look at, but also to inform, entertain, or even evoke subliminal feelings in the user. Yet, using color on the Web can be difficult because of the limitations of today's browser technology. Color reproduction is far from perfect, and the effect of Web colors on users may not always be what was intended. Apart from correct reproduction, there are other factors that affect the usability of color on the Web. For instance, a misunderstanding of the cultural significance of certain colors may cause a negative feeling in the user. In this chapter, color technology and usage on the Web will be covered, while the following chapter will focus on the use of images online.

Color Basics

Before discussing the technology of Web color, let's quickly review color terms and theory. In traditional color theory, there are three primary colors: blue, red, and yellow. By mixing the primary colors you get three secondary colors: green, orange, and purple. Finally, by mixing these colors we get the tertiary colors: yellow-orange, red-orange, red-purple, blue-purple, blue-green, and yellow-green. We now have a total of twelve colors, which are generally arranged as a color wheel, as shown in Figure 13-1. It is more colorfully presented at <http://www.webdesignref.com/examples/colorwheel.htm>.

We add to our basic color palette the neutrals: black, white, and gray. Recall that black is the absence of color while white is the combination of all colors.

From the twelve basic colors and the neutrals all the rest of the colors are born. Given a particular color, or more appropriately hue, we might modify the *value* or *brightness* of

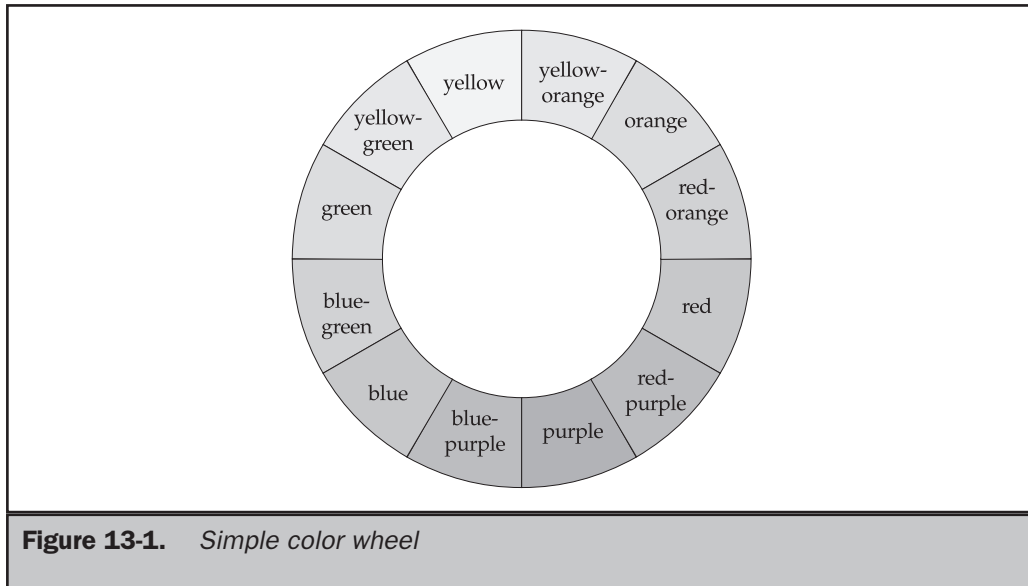


Figure 13-1. Simple color wheel

Hue	The color attribute identified by color names, such as “red” or “yellow.”
Value	The degree of lightness or darkness of a color.
Saturation	The relative purity of a color; also referred to as “intensity.” The “brighter” the intensity of a color, the more saturated it is. New jeans are saturated with blue; faded ones are a less-saturated blue.
Chromatic hues	All colors other than black, white, and gray.
Neutral colors	Black, white, or gray—otherwise known as “non-chromatic hues.”
Monochromatic	A color combination based on variations of value and saturation of a single hue.

Table 13-1. Basic Color Terminology

the color to create variations. For example, we might take the color blue and vary it from light blue to dark blue. It is also possible to modify the *intensity*. Intensity controls how bright or dull a particular color appears. You might think of intensity as purity; the higher the intensity, the more pure the color. Intensity is also described using the term *saturation*. These basic terms and a few others are defined in Table 13-1.

Computer Color

Computer monitors display colors using varying amounts of red, green, and blue, called RGB color. This is considered an additive form of color, because red, green, and blue light in equal amounts “add” up to white light. All other colors are formed on screen by varying the amounts of each color. For example, red and green are combined to form yellow, blue and green to form cyan, and red and blue to form magenta. This is demonstrated at www.webdesignref.com/examples/rgbcolor.htm.

Note

RGB color is completely different from the way colors are set in print. In print, CMYK (cyan, magenta, yellow, black) is the more common color scheme. The colors you see on a printed piece are the parts of the spectrum reflected back to your eyes as white light hits the ink. CMYK is considered subtractive color since, in theory, if you were to mix pure cyan, magenta, and yellow, they should absorb all color to produce black (because of impurities in all printing inks, however, these three don't actually produce black, which is why black (K) ink must be added).

Bits	Number of Possible Colors
32	16,777,216 (24 bits) plus 8 bits used for control information
24	16,777,216
16	65,536
8	256
7	128
6	64
5	32
4	16
3	8
2	4
1	2

Table 13-2. *Bit Depth and Possible Colors*

Each of the various dots or pixels (picture elements) on a computer monitor is set to a particular color to create imagery on screen. *Bit-depth*, sometimes referred to as *color depth*, is the term given to the number of bits used to describe color in an image or on a monitor. The basic idea is simple: the more bits used to specify a color, the more possible colors are available—more bits equals more colors. One bit can be used to specify two colors, typically black and white, two bits can describe four colors, three bits can describe eight colors, and so on. Notice that the number of colors specified by the bit-depth is simply 2 raised to the *n*th power, where *n* is the number of bits, as shown in Table 13-2.

A firm understanding of bit depth is important for a Web designer, as the bit depth of a visitor's monitor affects color reproduction, and the manipulation of bit-depth in images can be used to significantly decrease file size. Put simply, the higher the bit depth, the greater the number of colors; the greater the number of colors, the larger the file size. Reducing the number of colors will aid in lowering the file size of images and improve the download time of Web pages. Further consideration of this idea is given in Chapter 14.

Web Color Basics

Anyone familiar with Photoshop or similar programs will probably know the basics of RGB color. In such a graphics program, each of the three color elements, red, green, and blue, can have values from 0 to 255, generally expressed as three numbers separated by commas. So, in the RGB triplet 102,153,204, the number 102 is the red value, 153 is

the green value, and 204 is the blue value. All this is very well and good when you're working in a graphics program, but Web technologies do not always measure color with decimal values, but often rely on hexadecimal (base-16) values.

In HTML, color is specified by a hexadecimal RGB triplet preceded by the pound sign (#). The color is six digits long, two hex digits for each byte. So, in the RGB triplet #FF12AC,

- The first two digits (FF) represent the intensity of the red component of the pixel, which is at full strength because a byte cannot be greater than FF.
- The next two digits (12) represent the intensity of the green component of the pixel, which here is fairly low.
- The last two digits (AC) represent the intensity of the blue part of the pixel, and here it's fairly high.

The end result is a bright pink color that might be used in markup like this:

```
<font color="#ff12ac">Hot Pink!</font>
```

In HTML and CSS, we measure color in a hexadecimal range of 00–FF, which is equivalent to 0–255 in decimal. It's relatively easy to translate RGB values to hexadecimal values by referring to a translation chart, such as the one found in Appendix F. Given such a chart, a mid-range blue like rgb (102,153,204) would be represented in hex as #6699CC.

It also is possible to reference the color by name in the code (for example, "black"). The 16 basic names originally defined by Microsoft are now part of the HTML specification; these appear alongside their hexadecimal values in Table 13-3.

Color Name	Hex value
Black	#000000
White	#ffffff
Gray	#808080
Silver	#c0c0c0
Green	#008000
Lime	#00ff00
Olive	#808000
Yellow	#ffff00

Table 13-3. HTML Specification Colors

Color Name	Hex value
Aqua	#00ffff
Teal	#008080
Blue	#0000ff
Navy	#000080
Fuchsia	#ff00ff
Purple	#800080
Red	#ff0000
Maroon	#800000

Table 13-3. *HTML Specification Colors* (continued)

These are just a few of the colors available. By using RGB triplets translated to a hex value, it is possible to use 256 shades of red, green, and blue to create colors—somewhere around 16.4 million colors! There are over one hundred more color names originally introduced by Netscape and based upon the X11 windowing system colors. These colors are largely supported by most Web browsers. Believe it or not, they include such varied color names as “tomato,” “thistle,” and “lightcoral.”

Online: The full list of color names and their hexadecimal and RGB equivalents can be seen online at <http://www.htmlref.com/Reference/AppF/colorchart.htm>

One could, of course, use any word, such as pineapplesherbet (not a real value), as a color value; browsers will attempt to render them, but if they are not recognized color names, the rendering will have no relation to the meaning of the word. Our imaginary value pineapplesherbet renders as a shade of blue in Internet Explorer, but as a completely different, much darker blue in Netscape. Either way, it doesn't look like pineapple sherbet. Therefore, it is important to specify the exact color you wish to reproduce with its correct hexadecimal value in order to avoid different browser interpretations. For example, the defined color name aquamarine is equivalent to an RGB value of 127,255,212, which translates to a hexadecimal value of #7FFFD4. Unfortunately, as with many of the other named colors, this is not a browser-safe color. In general, it is preferable to use a hexadecimal code to indicate color. Doing so greatly reduces the chance that the color will be rendered incorrectly.

Rule: To ensure that the appropriate color is produced, always use a hexadecimal value over a named color, except in the case of basic VGA colors like white, black, red, and so on.

HTML Color Use

There are numerous ways to set colors in HTML. The elements (tags) that allow setting the color as an option include the background color of the document body, the default color of text in the document, the colors of links, the color of fonts used in the document, and background colors in tables.

Two basic document-wide color settings can be defined using the **body** element:

```
<body bgcolor="#ffffff" text="#000000">
```

This will provide the document with a white background, and the default color for text in the document will be black. In addition, the **<body>** tag has three attributes that define the colors for three different text link states:

```
<body link="blue" alink="red" vlink="purple">
```

The **link** attribute defines the color of unvisited links in a document. For example, if you've set your background color to black, it might be more useful to have a light link color instead of the standard blue. The **alink** attribute defines the color of the link as it is being clicked. This often happens too quickly to be noticed, but it can create a flash effect, if desired. For a more subdued Web experience, it might be better to set the **alink** attribute to match either the **link** attribute or the next one, **vlink**. The **vlink** attribute defines the color of a link after it has been visited, which under many browsers is purple. Many authors wish to set the value of the **vlink** attribute to red, which makes sense given standard color interpretation. So, using the code above, creating a white page with green text, red links, and fuchsia-colored visited links could be accomplished using the code presented here.

```
<body bgcolor="#ffffff" text="#008000" link="#ff0000"  
vlink="#ff00ff" alink="#ff0000">
```

Try not to choose link colors that might confuse your viewers. For example, reversing link colors so that visited links are blue and nonvisited links are red could confuse a user. While it is unlikely that a page designer would do such a thing, it has been seen more than once—particularly in situations where the look and feel is the driving force of the site. Other common problems with link color changes include setting all link values to blue in the belief that users will revisit sections, thinking they haven't been there before! While this may make sense from a marketing standpoint, the frustration factor due to the lost navigation cues may override any potential benefit from extra visits. As the last example showed, setting the link colors all to red could have the similar effect of encouraging users to think they have seen the site already.

It is also important to make sure that you do not set your links to the same color as the regular text on the page. Relying on underlining to be the definition of the link is

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extremely dangerous, since most browsers have the option to turn off underlining. Make sure that your link color is going to contrast enough with the paragraph containing it in order to avoid forcing your user to spend time figuring out if there are any links on the page.

Font colors, as well as all other font values, are controlled under traditional HTML through the `` tag. Focusing on colors exclusively, using `` is pretty simple. The following,

```
<font color="red">Red text!</font>
```

will produce red text, as will

```
<font color="#ff0000">Red text!</font>
```

Tables also can be assigned background colors in several ways. The `bgcolor` attribute is valid for `<table>`, `<tr>`, `<th>` and `<td>`.

```
<table border="1" cellspacing="0" cellpadding="8" bgcolor="green">
<tr>
<th bgcolor="lightblue">Lightblue</th>
<th bgcolor="lightblue">Lightblue</th>
<th bgcolor="lightblue">Lightblue</th>
</tr>

<tr bgcolor="orange">
<td>Orange</td>
<td>Orange</td>
<td>Orange</td>
</tr>

<tr>
<td bgcolor="red">Red</td>
<td bgcolor="white">White</td>
<td bgcolor="blue">Blue</td>
</tr>

<tr>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
</table>
```


In this code, the header cells (**th**) in the first row will have a light blue background; all three cells (**td**) in the second row will have an orange background, as defined for the entire row (**tr**); the three cells in the third row will have different background colors, as defined by the **bgcolor** attribute for each **<td>** tag; and the cells in the last row, which have no background color defined for themselves or their row, will default to the green background color defined in the **<table>** tag, as shown here:

Lightblue	Lightblue	Lightblue
Orange	Orange	Orange
Red	White	Blue
Green	Green	Green

Note that the **cellspacing** attribute for **<table>** is set to zero; if it is set to a higher value, the background color will display in the areas between cells in Internet Explorer:

Lightblue	Lightblue	Lightblue
Orange	Orange	Orange
Red	White	Blue
Green	Green	Green

Don't forget that if the **cellspacing** attribute is not included, most browsers will render the table with several pixels of cell spacing by default. Be sure to set it to "0" to prevent inadvertent spacing.

Some grouping elements associated with tables, like **<thead>** and **<tfoot>**, as defined in the HTML 4.0 spec, also accept **bgcolor**, but make sure to test for browser computability.

Additional proprietary attributes have also been defined for table elements. Internet Explorer supports a **bordercolor** attribute for **table**. Under IE 4 and higher, the following code,

```
<table bordercolor="#ff0000" border="1">  
<tr>  
<td>. . . content . . .</td>  
</tr>  
</table>
```

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will render a table with a red border around all the entire table and its cells. Netscape may render a red outline only around the four sides of the table and the effect is completely different from the IE rendering. Under IE, **bordercolor** can also be applied to rows (**tr**), headers (**th**), and cells (**td**).

Internet Explorer also provides two more border color attributes: **bordercolordark** and **bordercolorlight**.

```
<table bordercolordark="#ff0000" bordercolorlight="#0000ff"
border="4">
<tr>
<td>...content...</td>
</tr>
</table>
```

Under Internet Explorer, this will render a two-tone outer border for the table in which the top and left outer borders are blue, while the lower and right outer borders are red. It will have no effect in Netscape. Proprietary attributes are not recommended but are commonly employed, given the heavy Internet Explorer penetration.

Finally, on certain browsers some other HTML elements may support color. A common one is the horizontal rule (**<hr>**) tag. This is a proprietary use of the **color** attribute defined by Microsoft, so while

```
<hr noshade="noshade" size="1" color="red" />
```

will render a solid red rule under Internet Explorer 3 and higher, other browsers will ignore the **color** attribute and render the rule in default gray. Color setting for anything other than page background, table, link, and text should be left to style sheets.

CSS1 Color Use

So far we have discussed applying color values to various HTML elements using named values like **red** or hexadecimal values like **#ff0000**. The number of HTML elements that support such attributes as **color** and **bgcolor** is rather limited. Using CSS1 (Cascading Style Sheets, Level 1) opens up a whole new world of color possibilities, both in terms of expressing color values and of the number of HTML elements to which you can apply color.

First, CSS allows color to be applied both to the foreground and background of almost any HTML element. For example, to make all text in a document red, use the simple style rule:

```
body {color: red;}
```

You can also specify background color using the `background-color` property; so the following rule would specify a black background for the page with red text:

```
body {background-color: black; color: red;}
```

The specification of colors can happen on single tags or groups of tags so that instead of using `<table>` tags with background colors, you might resort to simple rules like,

```
em {background-color: orange; color: black;}  
strong {background-color: yellow; color: purple;}
```

to accomplish the same look with far less markup. Consider what it would take to implement the look here:

CSS make setting colors and background easy!

Without CSS, it would certainly take some careful table code—or you might just give up and make it an image.

Color in CSS, as in HTML, can be specified using traditional hexadecimal color values, for example:

```
body {background-color: #000000; color: #FF0000;}
```

However, you could also use this approach in this case for a red font:

```
body {background-color: #000; color: #F00;}
```

CSS1 and CSS2 support a sort of condensed hexadecimal code, where black would be `#000`, blue would be `#00F`, and so on. Browser support is variable, so be careful when applying these color values.

PhotoShop users will appreciate another CSS color value approach: RGB values. No need to convert RGB values to hex with this technique.

```
span {color: rgb(0,0,255);}
```

Most CSS browsers support this approach, in which the color value is defined by the letters `rgb` (lowercase) followed by three-comma-separated RGB values in parentheses. It is also possible to use percentage values instead of decimal values, as for example:

```
span {color: rgb(100%,0%,0%);}
```

CSS2 Color Use

The main change in CSS2 in regard to color is the ability to set color values that are related to the user's current graphical environment. The idea here is that we can now specify colors in a relative manner so that the Web page integrates itself into the user's graphical environment. Imagine a user with a customized red desktop. We might want our various page and GUI elements to match this desktop. Apart from aesthetics, system settings may be adjusted to suit a user's accessibility needs. If we adjust page colors to suit, it may improve the accessibility of the page. The color values defined in Table 13-4 can be applied to any color property, like **color** or **background-color**. They should be cased as presented below for readability.

CSS2 Color Value	Description of Color Relation
ActiveBorder	Active window border
ActiveCaption	Active window caption
AppWorkspace	Background color of multiple document interface
Background	Desktop background
ButtonFace	Face color for 3-D display elements
ButtonHighlight	Dark shadow for 3-D display elements
ButtonShadow	Shadow color for 3-D display elements
ButtonText	Text on push buttons
CaptionText	Text in caption
GrayText	Grayed (disabled) text
Highlight	Item(s) selected in a control
HighlightText	Text of item(s) selected in a control
InactiveBorder	Inactive window border
InactiveCaption	Inactive window caption
InactiveCaptionText	Color of text in an inactive caption
InfoBackground	Background color for tooltip controls
InfoText	Text color for tooltip controls
Menu	Menu background

Table 13-4. *CSS2 System Color Values*

CSS2 Color Value	Description of Color Relation
MenuText	Text in menus
Scrollbar	Scroll bar gray area
ThreeDDarkShadow	Dark shadow for 3-D display elements
ThreeDFace	Face color for 3-D display elements
ThreeDHighlight	Highlight color for 3-D display elements
ThreeDLightShadow	Light color for 3-D display elements
ThreeDShadow	Dark shadow for 3-D display elements
Window	Window background
WindowFrame	Window frame
WindowText	Text in windows

Table 13-4. CSS2 System Color Values (continued)

You use these values just as you would use any other color; for example, a simple rule that sets the background of the page to match the desktop background would be

```
body {background-color: Background;}
```

The 6.x generation browsers have provided some support for these values. However, page authors are encouraged to use them carefully, as the distinction between desktop and Web application for now should be kept clear.

Possible CSS3 Color Use

While it is still early to state safely what browsers will support in the upcoming CSS3 specification, some aspects of color support deserve at least a brief mention so as to point at future possibilities.

First, the CSS3 specification allows for opacity to be set for elements. This can also be set via a modified color specification indicated by `rgba`, which adds alpha as a fourth value. The alpha value ranges from 0.0 (fully transparent) to 1.0 (fully opaque). Under CSS3, we might use rules like this:

```
em {color: rgba(255,0,0,1);} /* red fully opaque */  
strong {color: rgba(0,0,255,0.5);} /* partially transparent green */
```

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Another improvement introduced in CSS3 is the ability to set color in Hue Saturation Lightness (HSL) format. HSL colors are specified as a triple (hue, saturation, lightness). Hue is represented as an angle of the color circle, where red is 0 or 360, green is 120, blue is 240, and the other colors spread in between. Saturation is represented in a percentage, so 0% is no saturation or a shade of gray, while 100% is full saturation of the hue. Lightness is also represented as a percentage value, with 100% lightness being white and 0% lightness being black. A lightness value of 50%, specifying a “normal” value, would be commonly used. Given these specifications, the following CSS rules make sense:

```
.red {color: hsl(0, 100%, 50%); }  
.green {color: hsl(120,100%,50%);}  
.darkgreen {color: hsl(120,100%,75%);}  
.lightgreen {color: hsl(120,100%,25%);}  
.blue {color: hsl(240,100%,50%);}  
.white {color: hsl(0,0%,100%);}  
.black {color: hsl(0,0%,0%);}
```

While this may seem to be just another way to specify color, the HSL color specification is more intuitive to adjust, and it is generally easier to create variations of colors by keeping the hue the same and adjusting saturation and tint.

Like the RGB color specification, HSL colors under CSS3 should also support alpha values and are measured by HSLA (hue, saturation, lightness, alpha). For example,

```
.translightgreen {color: hsla(120,100%, 25%, 0.5);}
```

would specify a semitransparent light-green color.

Finally, CSS3 should introduce properties like `color-profile`, which will allow the specification of an ICC (International Color Consortium) color profile (<http://www.color.org>). For example, to correct colors for images in the page under CSS3, a rule like

```
img {color-profile: url("http://example.com/profiles/eg.icm"); }
```

might be employed. The ability to improve color reproduction in browsers has been a long time in coming. The real challenge we see with color on the Web is that, with such a wide variety of viewing environments, the difference between what colors we specify and what actually shows up can be quite large if we are not careful.

Practical Web Color

The reality is that color often does not reproduce correctly in Web pages. The most common reason is related to bit-depth, as a color may be beyond the range of the viewing display environment. Alternative colors may be employed, or color shifting

may occur. Of course, even when a visitor's system is capable of displaying a color, technical features ranging from hardware age to Gamma control may cause that lovely shade of brown to turn into onscreen mud. The improper reproduction of color isn't just an issue of aesthetic integrity, as such problems may result in such poor contrast as to render pages all but unusable. Given today's technology, color manipulation in the Web environment can be challenging.

Browser-Safe Color

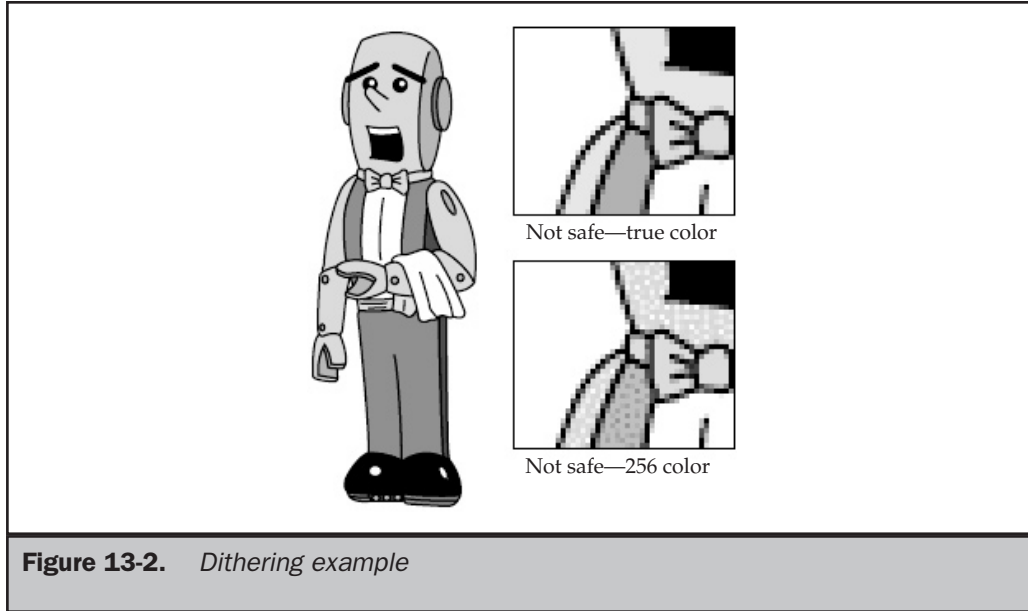
What are the browser safe colors, and why is it important to use them? The first step in answering this question is to ask another question: What controls the colors that can be displayed on a computer? These colors are controlled by the computer's video card and limited by the capacities of the monitor being used. The range of colors can vary anywhere from 256 colors and below on the low end all the way up to millions (and "true color") on the high end. Some older systems may even support only 16 colors. In order to be completely safe for all systems, Web design must concentrate on the lowest common denominator, but how can we predict what that is going to be? We can't, really. Many of the newer systems available today are more than likely to have all the colors needed to display all of your images, but we must play it safe and assure that those who have only 256-color capability will not have a terrible experience.

So how do we figure what those 256 colors are? The 256 colors supported by a PC are not the same as those supported by a Macintosh; most of them are the same, but 40 are actually different. That leaves 216 colors that will be guaranteed to be "safe" and display correctly, regardless of the platform or video card. What happens if you use a color that is not one of the 216 Web-safe colors? Quite often, nothing; if a user's computer can display more colors, then it will not have any problems rendering the color you chose, as long as the color is in that computer's palette, but what happens if they do have only 256? In these cases, their computer will try to re-create the color by using a technique called *dithering*.

Dithering is a process through which the computer attempts to re-create the desired color by using those it has available. It will do this by using two or more colors in a dithered (speckled or dotted) pattern to try to match the color it doesn't have, as shown in Figure 13-2. You can see a better example of this in our dithering demo at <http://www.webdesignref.com/examples/dither.htm>. Dithered images can look terrible and reflect poorly on the designer. By paying attention to the Web safe palette, it is possible to avoid most instances of dithering.

So how do we use the browser-safe colors? Well, it is pretty easy to make simple hex colors. Given the normal hex color triplet, you have RRGGBB, where RR, GG, and BB represent the hex values for red, green, and blue. Safe colors are those where RR, GG, and BB are only the values 00, 33, 66, 99, CC, or FF. Thus #FF00CC is a safe color, while #FFF5EE is not. You might wonder why these values? They represent exact 20% increments in saturation that give us a wide range of colors. So converting from hex, we see decimal values of 0, 51, 102, 153, 204, and 255 as the allowed values for **rgb** (R,G,B) measurements. The percentages for the safe values are 0%, 20%, 40%, 60%, 80%, and 100%

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respectively. Table 13-5 summarizes these basics rules, which you should commit to memory if you plan on producing Web graphics frequently.

A complete palette in full color with both hex and RGB values is present in most graphics programs and can also be found at <http://www.htmlref.com/reference/AppE/index.htm>.

RGB Value	Percentage Value	Hexadecimal Value
255	100%	FF
204	80%	CC
153	60%	99
102	40%	66
51	20%	33
0	0%	00

Table 13-5. *RGB/Hexadecimal Equivalents*

If you use colors outside the safety range in an 8-bit viewing environment, you should see dithering or color shift. To ensure that colors reproduce correctly, particularly in GIF images, you will want to use a graphics program like Adobe PhotoShop or Macromedia Fireworks and make sure the palette used is “Web-safe” or that you “snap” to the safety palette once you save out.

Given how quickly computer technology is advancing and how few people probably use 8-bit displays, does any of this matter? As we discussed earlier, the majority of newer systems today will have a much greater color capacity than 256. So what do you design for? Or, to put it differently, why should you limit your designs to the lowest common denominator? It’s very hard to say. If you have a specific target audience and you know what they have, such as an internal company intranet, then you can definitely design for that audience’s capability. Since the majority of the time you don’t know what your users are going to have, you are either going to have to assume some minimum platform or detect for user capabilities. However, if you end up assuming a base platform, remember that some users might not see colors properly—since it is possible to do exciting, high-quality design within the boundaries of Web-safe color palettes, why take the risk at all? We will examine next a few approaches for breaking the browser safety barrier. However, be sure to read the section entitled “Color Shifting and the Reality of the Web Palette” to gain a proper perspective on this issue.

Note

Another interesting trend that seems to encourage the use of the browser-safe palette regardless of monitor support is download time. With GIF images, color reduction is the easiest way to reduce file size, so even though most Web users can see more than 256 colors, many sites continue to design around very restrictive color palettes.

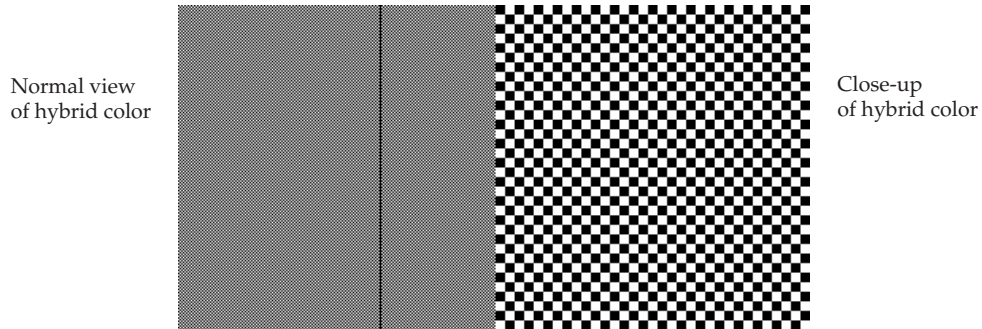
Hybrid Colors

In their quest to beat the 216-color limitations of the Web-safe palette, designers have come up with a simple workaround generally referred to as *hybrid colors*. Taking advantage of the smallness of pixels and the human mind’s tendency to fill in the blanks in visual information, hybrid colors simply take two or more Web-safe colors and combine them in some pattern—usually a checkerboard, but sometimes stripes—to trick the eye into seeing a different color. In a sense, this is a form of controlled dithering that, if done properly, the end user will not notice.

Suggestion: To safely break the 216-color barrier, use pre-dithered patterns (so-called “hybrid colors”).

In the next illustration, the area on the left that appears to be gray is actually a checkerboard made up of single-pixel black and white squares, as shown on the right.

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Online: Demos of hybrid colors can be viewed at <http://www.webdesignref.com/examples/hybridcolor.htm>.

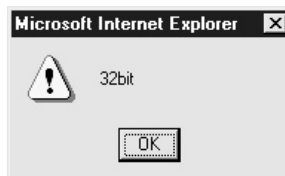
Various tools, such as BoxTop's ColorSafe plug-in for PhotoShop (<http://www.boxtopsoft.com>), can aid designers in creating hybrid colors quite easily. In the end, however, the real decision is whether you can design within the constraints of the Web-safe palette. By remaining within that range as much as possible, you maximize the usability of your Web site.

Color Detection

Another approach to dealing with the color variability issue is to detect for user capabilities using JavaScript. In 4.x generation browsers and better, the JavaScript Screen object can be used to determine the bit-depth of the user's monitor by accessing the **colorDepth** property. For example, this short script displays the current color depth in an alert dialog:

```
<script type="text/javascript">  
<!--  
if (window.screen)  
alert(window.screen.colorDepth+"bit");  
//-->  
</script>
```

The dialog box is shown here:



In view of the color detection capability, you might consider setting screen colors based upon user screen conditions. A style sheet reference based upon the color support could be written:

```
<script type="text/javascript">
<!--
var bitDepth;

if (window.screen)
    bitDepth = window.screen.colorDepth;
else
    bitDepth = 8;

if (bitDepth > 8)
    document.write('<link rel="stylesheet" href="hicolor.css" media="screen" />');
else
    document.write('<link rel="stylesheet" href="locolor.css" media="screen" />');
//-->
</script>
<noscript>
<link rel="stylesheet" href="locolor.css" media="screen" />
</noscript>
```

It might be a lot of work, but detection is a slight improvement over mere guesswork in achieving accurate color reproduction. Unfortunately, so far, without color reproduction profiles in Web browsers, there are many things that can derail our efforts.

Troublesome Color Reproduction Issues

There are many other issues that can affect the display of colors on the Web. This section will discuss several of them, including color shifting, gamma correction, and types of monitors. Remember, while you may develop your designs on a 21-inch top-of-the-line monitor, your users will probably be viewing your creation on something much different.

Color Shifting and the Reality of the Web Palette

Here's the bad news: even the Web-safe palette isn't Web-safe under many conditions. The monitor does not really determine the number of colors that can be displayed. The number of available colors is actually defined by the computer's video card. In our lowest common denominator scenario of 256 colors, 8 bits are employed to display colors. (Remember: 2 to the 8th power is 256.) For more colors, the computer must allocate more memory to process colors. High color (16-bit) produces over 65,000 colors, while 24-bit provides literally millions of colors. This may really be overkill, as studies have shown that the average person cannot tell 16-bit and 24-bit color apart. On the other hand, 8-bit and 16-bit are fairly easy to distinguish.

For reasons of simple mathematics, 16-bit displays have some problems with the accurate display of the 216 Web-safe or browser-safe colors discussed earlier in this chapter. High color monitors were originally intended for print designers, who work with CMYK—a four-value system—rather than RGB—a three-value system. If you're working in CMYK, 16 divided by 4 yields a handy 4 bits per color channel. But if you're working in RGB, you run up against a troublesome issue. You can't split a bit, so in 16-bit RGB you wind up with 5 bits per color channel; the 16th bit either vanishes into some electronic limbo or is assigned arbitrarily to one of the three channels, depending on the system. A color channel with 5 bits can produce 32 different colors; raise that to the power of 3, and you get 32,768 colors—not quite the 65,000+ you'd get in CMYK. Ever get the feeling you're being cheated?

The Web-safe palette, on the other hand, divides each color channel into six values. Because 32 can't be divided exactly by 6, the colors defined by the Web-safe palette won't necessarily match the colors defined by a 16-bit color setting. Thus, on some systems, some of the Web-safe colors may shift their values slightly. It turns out that only about 22 of the supposed Web-safe colors don't shift at all. The Web-safe color palette appears to be unsafe! To many Web designers, this is the equivalent of saying the earth is flat, but it is true. See <http://www.morecrayons.com> for links to articles that go into great detail on this issue.

Given this potentially earth-shattering information, should a designer even care about the Web-safe colors anymore? The answer: probably not as much. An alternative palette that is more 16-bit friendly contains 4096 colors and can also be found at <http://www.morecrayons.com>. This certainly helps increase what we can design with and addresses the majority of Web users—but you might wonder if color shifts occur on a 24-bit display and how 8-bit folks will view your site? You might just want to stick to primary colors, as many designers do. Other designers just completely ignore the problem and design with the full 16-bit palette. Finally, you could use JavaScript to detect for bit-depth and go from there, but that could get complex.

To add even more complexity to the color shifting issue, different components of a Web page may be affected differently. Remember, a Web browser is a program; the part of that program that processes GIF images may process a certain color one way, while the part of that program that processes HTML may shift the same value somewhat differently when rendering a background color. This can result in an image not matching a background, even though you've taken great pains to keep that shade of red to the correct value. More information on this issue can be found at <http://www.macromedia.com/go/13901/>. The unpredictable nature of interactions between video cards and monitors is further compounded by the rendering inconsistencies of the browsers themselves.

Gamma Correction

Gamma correction changes the overall brightness and color saturation of an image as it is displayed on a monitor. If a display is gamma-corrected, the nonlinear relationship between pixel value (the number assigned to a particular color tone) and displayed

intensity (the way it actually looks) has been adjusted for. To get an idea of what this means visually, take a look at <http://www.webdesignref.com/examples/gamma.htm>.

To understand gamma, we need to delve a little deeper into the inner workings of monitors. The purpose of gamma correction is to adjust a monitor so that it boosts the voltage in a manner consistent with other monitors. Computers send a certain voltage to monitors, which control the electron emissions that tell the pixels on the screen which colors they should display. The monitor, in turn, boosts the signal by increasing that voltage a certain amount, which may be as high as 2.5 times the original voltage. But since the original voltage, which varies for different colors, is usually less than 1 volt, this may not account for much. Variations in the amount a monitor boosts this voltage will cause different monitors to display the same color differently. Brightness and contrast are both affected. Browsers with incorrect gamma correction will look darker and have less contrast. This is not just a matter of brightness, as gamma settings also affect the ratios between the levels of red, blue, and green.

Macintosh computers are generally regarded as better in this department, and with good reason: they were meant to be used in the creation of graphics (originally for print), while this has only become a recent concern for PCs. As it stands, Macs are set to a gamma setting of 1.8, and PCs are set to 2.5. Macs default to “corrected” gamma, which means the video signal is absolutely true to the source data—which is what a print designer needs. Most Windows PCs display “uncorrected” gamma, just like television, which skews midtones to be 10–15% darker and more saturated. For this reason, many experts suggest that once Web designers get their gamma set up correctly, they should work with an average gamma of 2.2 in mind. Gamma-correction software can be implemented by technicians, or you can do it yourself. PhotoShop allows designers to preview an image’s appearance under various gamma settings. Recent Web-specialized graphics programs like Fireworks and ImageReady have the ability to gamma-preview images, as well as to batch-process images to use a selected gamma value. If you are working on low-contrast designs, understanding the lack of gamma correction on the average PC monitor will help you avoid creating muddy, indistinct imagery.

In theory, gamma issues should not affect CSS and HTML colors, but the reality is that there are at times differences between colors in PC and Mac environments. Until color profile information is included, it might be best to stick with common colors or put up with imperfect color reproduction, as even the latest display technology seems to make things more complicated.

Monitor Types: CRT vs. LCD

Most desktop computer monitors are CRT (Cathode Ray Tube) display devices, just like a television monitor. The inside of a CRT monitor screen is covered with thousands of phosphor dots. Three of these dots—one red, one green, one blue—make up a pixel. The phosphor dots glow in response to charges emitted by an electron gun at the back of the monitor. As noted above, however, color processing begins in a computer’s

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video card, not in the monitor. Using a Digital to Analog Converter (DAC), a computer monitor translates the digital information from the video card into an analog signal that controls the monitor's electron gun. Sudden and erratic variations in a monitor's color display may be caused by problems with the DAC circuit. When encountering serious color distortion, always test the monitor on a different computer before blaming the wrong piece of hardware for the problem.

Other issues with CRT monitors include flicker; this occurs when the phosphor dots inside the screen, which have been stimulated by electron streams, begin to lose their charge before it is refreshed. Setting your monitor to a refresh rate above 70 Hz should take care of this; although the Video Electronics Standards Association (VESA) defines 85 Hz as the standard, this may be more than is required. Setting the refresh rate too high can cause damage to a monitor. There are several types of CRT monitors, such as aperture-grille and shadow-mask, but this area is beyond the scope of this discussion.

LCD (Liquid Crystal Display) monitors, long used for laptop computers, are becoming more commonly used as desktop monitors, as the technology has improved sufficiently to make larger screens feasible and affordable. Since LCD monitors don't need room for an electron gun, they are "flat" and take up, on average, only a third of the space needed for bulkier CRT monitors. Other factors in their favor include a complete lack of cathode ray emissions, making them easier on the eyes, and significantly lower power requirements. The upswing in LCD monitor use has several ramifications in terms of color use.

First, many LCD screens, particularly smaller ones, may handle only thousands, or even hundreds, of colors and also tend to support a narrower range of screen resolutions. Larger and/or more expensive ones are more likely to handle millions of colors, or true color. Brightness may also be a concern, as LCD monitors are backlit, and their brightness levels may vary more than those of CRTs. The most important color issue for LCD monitors has to do with the angle of view. They need to be viewed head-on for best results, but even then, light variations caused by the orientation of the screen surface may cause the same color to look somewhat darker at the top of the screen and lighter at the bottom, or vice versa. Given this, LCD screens are probably a poor choice for doing graphics design for Web sites (or any other medium), unless your lighting conditions are very well controlled. From a designer's viewpoint, this reinforces the importance of choosing well-contrasted and coordinated colors for Web pages.

Using Color

Even when color is reproduced properly, it isn't difficult to abuse it. A few too many drastically different colors in use at once might be so garish as to drive users away. Color harmony attempts to find pleasing combinations of colors. Yet even when harmonious, colors may not provide enough contrast and thereby affect usability. Finally, colors have implied meanings that should be considered.

Color Harmony

When using color, designers generally attempt to put things in balance. Too much color can be over stimulating and chaotic, while too little color can be boring. When using color, we strive for harmony—in other words, we use color in a pleasing way. Of course, while this may seem to be more a matter of taste, color theory has long shown how certain color combinations work well together, while others do not.

The most basic tips for good color use are

- Use only a few different colors on a page.
- Do not use an excessive amount of colors.
- Use hot and cool colors together.

We can come up with some common schemes for finding pleasing color combinations using the color wheel presented earlier in the chapter. The simplest way to do this is to select colors near each other on the color wheel. The scheme is described as *analogous*. Colors directly opposite on the color wheel also work well together and are considered *complementary*. For variation, you can try nearly complementary colors or three colors that form an equilateral triangle in the color wheel. Such a color scheme is called a *triadic* color scheme. Color harmony diagrams illustrating the previous ideas are shown in Figure 13-3, with examples found at www.webdesignref.com/examples/colorharmony.htm.

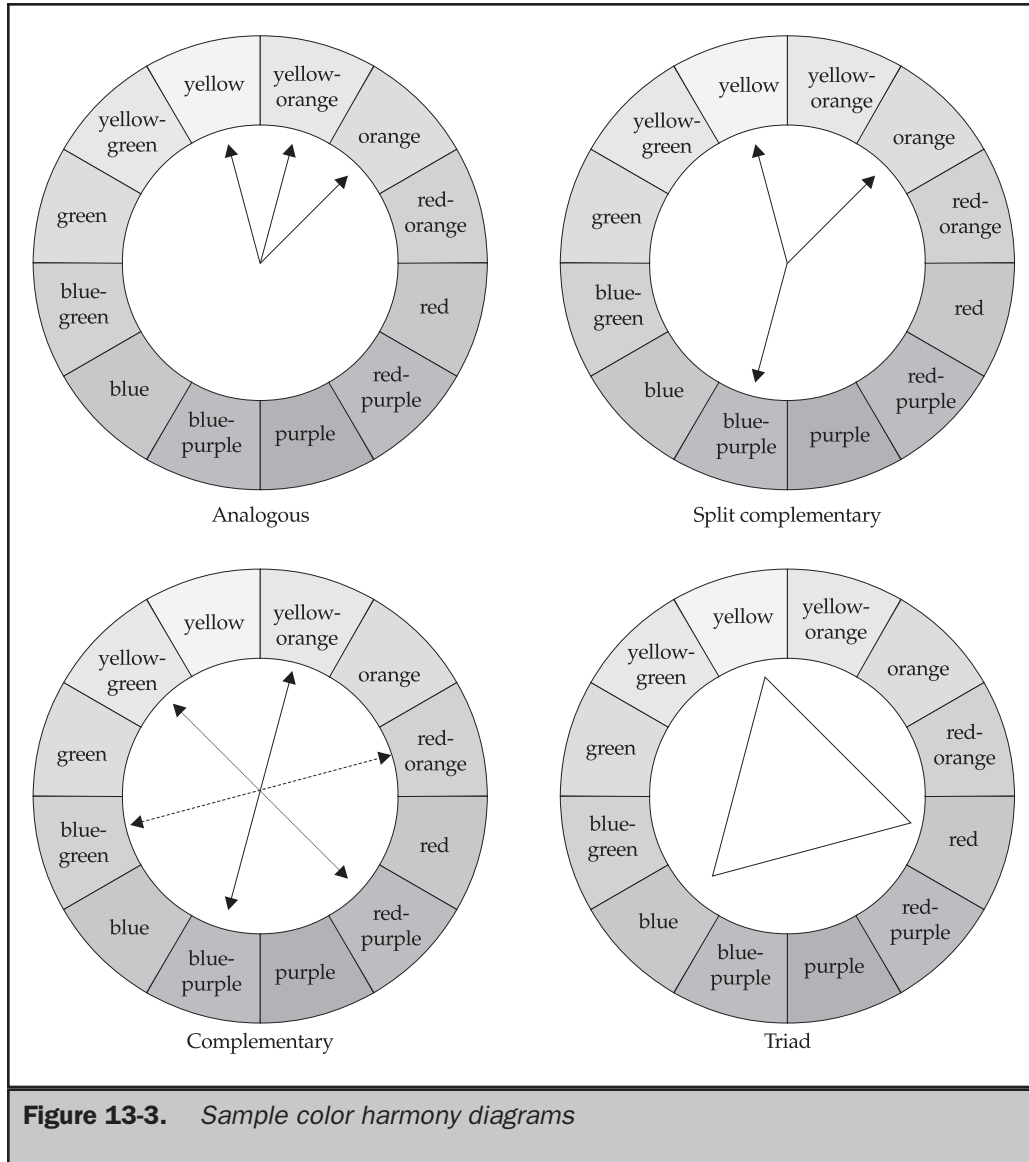
Finally, plain black and white plus a color is the easiest harmony. While a little boring, it is safe and looks pleasing, particularly if the color used is vibrant so as to show contrast with the neutral black and white.

Color and Usability

Page authors must also be extremely careful when setting text and background colors. Readability must be preserved. Page designers are often tempted to use light colors on light backgrounds or dark colors on dark backgrounds. For example, a gray text on a black background might look great on your monitor, but if the gamma value of another person's monitor is much different than your monitor, it will be unreadable. An online demonstration of contrast problems can be found at <http://www.webdesignref.com/examples/contrastandusability.htm>.

The simple solution to the color usability problem is to make sure to never have elements that require a precise rendering in order for the difference to be apparent. A non-main element, one whose disappearance wouldn't affect the overall look of the page, might qualify as an exception to this rule, but if your design requires that everything appear precisely rendered in order for the whole to not fall apart, then you will need to modify your design.

To avoid color contrast problems, white and black always make a good pairing, and red is certainly useful. The best color combination in terms of contrast is yellow and black, but imagine the headache from reading a page that looks like a road sign!



Despite the high contrast, designers should be careful of white text on a black background when font sizes are very small, particularly on poor-resolution monitors.

Yet be careful also of exaggeratedly high contrast. Bright neon colors on a black background offer a great deal of contrast, but is it an effective or usable design? As mentioned in the previous section on color harmony, using color and contrast to call

attention to particular parts of a site is a balancing act. Making the navigation colorfully obvious without making it obtrusive and at the same time highlighting a special site feature can be challenging, because just as fast as you grab attention, you may generate a negative response.

Another aspect of color and usability to consider is the variation of visual capabilities in Web users. Human color perception simply does not adhere to some exact standard (considering that the health and structure of each person's eyes varies greatly, this is somewhat to be expected). For example, it is estimated that approximately eight percent of all men and one percent of women have color vision deficiency to some degree or another. Users with vision that is somewhat color-deficient are often unable to differentiate between colors of similar hue when those colors are of the same lightness and saturation. Someone with the most common color deficiency, red-green color blindness, would have trouble distinguishing between red and green when the red and green are close in saturation and lightness. Such color vision issues can be troublesome when you consider the difficulty in distinguishing between red and green traffic lights. Does the color-deficient driver really know when to stop or go? Probably yes, since position also provides meaning in a traffic signal. However, on the Web, if links are similar in hue, lightness, and saturation, it might be difficult for someone to determine which links have been visited and which have not. If color is being used to draw something out, try to have something that also indicates importance, just in case the user can't perceive color properly.

Color perception problems may get worse with the proliferation of PDAs, cell phones, and Palm devices. What do you do when you are not working with lots of color? Can you design a site that works well in all conditions? Two-tone devices, usually displaying with a greenish-gray background and grayish-black text, challenge design ingenuity in a number of ways. The safest approach is probably to design a separate site for each browsing platform so that you can design completely within a particular visual environment. Browser-sensing then directs incoming users to the version of the site appropriate to their display device.

The last point about color and usability on the Web is once again related to links. Like it or not, on the Web blue equals go and purple equals stop or go away. Making something blue will encourage a person to click on it, making it purple will probably not. If you use lots of purple on the page, you might just be subliminally telling people that this site is one they should pay less attention to. Color isn't just for decoration; it can have meaning.

The Hidden Meaning of Colors

On the Web, particularly when dealing with international visitors, it's easy to get messed up by a potentially tricky issue: the meaning of color. Artists, philosophers, scientists, religious thinkers, and others from all walks of life have pondered this issue for centuries, but no consensus has been reached. The nineteenth century German writer and thinker Goethe spent a large portion of his life developing a theory of colors—most of which has

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been consigned to the dustbin of philosophy by modern thinkers. Even setting aside highly codified color/concept schemas—such as those used in Tibetan religious art or the changing colors of the liturgical seasons in Western churches—it is difficult to apply specific meanings to specific colors. In the West, black is largely associated with death and somber thoughts—while in Japan, the color associated with death is white, a complete reversal of the Western viewpoint. Considering that the Web is an international medium of communication, it may not be practical to take culturally accepted color meanings for granted. Bearing in mind the Western cultural background of this book’s production, Table 13-6 lists some common meanings people may associate with certain colors.

red	hot error stop warning	aggression fire lushness daring
pink	female cute cotton-candy	
orange	warm autumnal Halloween	
yellow	happy caution sunny	cheerful slow down
brown	warm fall dirty	
green	envy pastoral jealousy	inexperience fertility newness
blue	peaceful sadness water male	
purple	royalty luxury	

Table 13-6. *Common Concepts Associated with Colors (Subject to Cultural Bias)*

black	evil death mourning	ghostly night fear	cool
gray	overcast gloom old age		
white	virginal clean innocent	winter cold	

Table 13-6. *Common Concepts Associated with Colors (Subject to Cultural Bias)*
(continued)

Even without the complications of cultural associations, Web conventions also use color to convey meanings. The significance of hyperlink colors is brought up throughout this book—people are used to clicking on blue text to go somewhere else, and they know that purple text means they’ve already been there. Changing the color of hyperlinks is always a questionable proposition, especially if the audience for the site are not experienced users—they may see light blue text and never think to click, because they know that regular links are blue. However the messages may be subtler and more difficult to pin down. Reflect on what you think when you see a Web page with red text on a black background. How often does this make you think “Amateur!” in terms of the site’s designer? How do you respond to sites that do not have a white background on text-heavy pages? Every Web user brings a host of unacknowledged expectations about what colors, or combinations of colors, mean in the browser window.

Summary

Color is important to Web designers, as it makes pages both pleasing and meaningful to visitors. Unfortunately, color use on the Web can be difficult. With the wide variability of viewing environments, designers need to continue to rely on the 216-color browser-safe palette. Hybrid colors and color depth detection can help us break the 216-color limit safely, but even then things may not work. Without color correction technology that can deal with differences in the user’s viewing environment, color reproduction on the Web is far from an exact science. This is a rather unfortunate situation. Color preciseness is important if we want to make sure that the blue shirt users buy online is exactly the shade of blue they thought it was. Just think of the cost of returns due to a serious color shift! With the eventual introduction of color profiles in CSS (and PNG images, discussed in the next chapter), things should improve. Yet even when color is displayed properly, it is easy to misuse color by not using harmonious colors, providing too little contrast, or not considering the meaning of color.

