15. What are three benefits of maintaining unity of design?

Lesson 2
Color Models, Images, and Fonts

Objectives

Students will describe common color models. Students will classify images as raster or vector. Students will discuss interpolation and resampling of digital images. Students will identify serif and sans serif fonts.

Color Models

Colors are defined using a ***color model,*** which is a way of mixing base colors to create a spectrum of colors. The RGB and CMYK color models are the most common color models used in graphic design. The name of the *RGB* color model comes from the three base colors used in the color model: red, green, and blue. All of the colors you see on a computer screen are made by mixing these three base colors. The name of the *CMYK* color models comes from the process colors used in commercial printing: cyan, magenta, and yellow. K stands for key color. The most detail in a printed image appears in the key color, which is almost always black. Other color models include hue, saturation, luminescence (HSL); hexadecimal; and L*A*B* color, as shown in **Figure 2-1.**

The *hue, saturation, and luminescence (HSL)* color model, also known as the hue, saturation, and brightness (HSB) color model, creates color by adjusting these elements. Hue is the pigment color, saturation is how dark or rich the color is, and luminescence or brightness is how much light is shining on the color. This model is popular in creating textures and surfaces for 3D models. Since 3D models require the use of light and shadow to define position relative to the light source, using this color model allows the computer to leave the hue and saturation of the texture unchanged while adjusting the luminescence setting to be brighter on the surface facing the light source and darker on the surface facing away from the light source.

Hexadecimal color model is an RGB color model in which colors are represented by a series of six letters and numbers. This color model is used in web page design.

Color Model	Features	Method
HSL (also known as HSB or HSV)	Creates color by a combination of hue, saturation, and luminescence (or brightness or value). This model is popular in creating textures and surfaces for 3D models. Since 3D models require the use of light and shadow to define position relative to the light source in the game, using this color model allows the computer to leave the hue and saturation of the texture unchanged while adjusting the luminescence setting to be brighter on the surface facing the light source and darker on the surface facing away from the light source.	Additive
RGB	Creates color by a combination of red, green, and blue. Blending these three colors allows for over 16 million colors at 8-bit depth.	Additive
RGBA	The RGB color model with support for alpha channels. Alpha channels are transparency channels. The alpha channel sets the saturation of an RGB color from full opacity (not see-through) to full transparency (completely see-through).	Additive
Hexadecimal	An RGB color model in which the color is represented as a series of six letters and numbers. This color model is used in web page design. Many imaging software programs allow the user to limit colors to "web only," which are 216 colors universally compatible with web browsers.	Additive
CMYK	Creates color by a combination of cyan, magenta, yellow, and a key color that is almost always black. This model is used for printed materials. Each of the colors corresponds to one of the four printing plates on a printing press.	Subtractive
L*A*B*	The description of the L*A*B* color model is a bit complicated as the L is for lightness and the A and B components are derived from a nonlinear color matrix, similar to an X,Y coordinate graph. This model seeks to create natural looking colors. Additionally, L*A*B* color model is used to convert RGB color models to CMYK color models or vice versa. L*A*B* color works for both video displays (RGB) and printed materials (CMYK) and is considered device independent.	Matrix of both additive and subtractive combinations

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Figure 2-1.

A comparison of common color models.

Many imaging software programs allow the user to limit colors to "web only," which are 216 colors universally compatible with web browsers.

The *L*A*B** color model seeks to create natural colors as the human eye would see them. The description of the L*A*B* color model is a bit complicated as the L is for lightness and the A and B components are derived from a nonlinear color matrix, similar to an X,Y coordinate graph. Additionally, L*A*B* color model is used to convert RGB color models to CMYK color models or vice versa. L*A*B* color works for both video displays (RGB) and printed materials (CMYK) and is considered device independent.

The total spectrum of colors a given model can create is called the ***gamut.*** Colors are assembled or blended using an additive or subtractive method. The *additive method* starts with no color, or black, and colors are added to create the final color. White in an additive color model is the combination of all color wavelengths in light. In the RGB color model, black is red 0, green 0, and blue 0. This means no color is added to the black screen. White is red 255, green 255, and blue 255. This means the maximum amount of all three colors is added to the black screen.

The *subtractive method* starts with all color, or white, and colors are removed to create the final color. For example, when you look at a red object, all color wavelengths in the light are absorbed by the paint (subtracted) except for red. What you see is the red wavelength. White is the reflection of all color wavelengths, so no color is subtracted. Black occurs when no color wavelengths are reflected, so all color is subtracted. CMYK is a subtractive color model. Black is cyan 100%, magenta 100%, yellow 100%, and key 100%. White is cyan 0%, magenta 0%, yellow 0%, and key 0%.

Images

There are two basic types of images: raster and vector. All images created using a computer fall into one of these two categories. Additionally, digital images may be compressed to save storage space and reduce transmission times.

Raster Images

Raster images are images that are made of dots or pixels. Each pixel in the image has a specific color and location to construct the final image. A raster image is called a *bitmap* because the location and color of each pixel is mapped. The computer reads a bitmap image by creating a coordinate grid with the origin at the top-left corner and increasing the X value moving right and the Y value moving down. In each space of the coordinate grid is a single pixel. A pixel can only be one color. To determine the color of a pixel at a particular coordinate location, the color value of a pixel is read by the computer and displayed.

Originally, bitmaps were only made at a bit depth of 1. ***Bit depth*** is a binary measurement for color. Binary allows for only two values, either a 1 or a 0. A bit depth of 1 describes the exponent value of the binary digit. A bit depth of 1 means 2^1. A bitmap value of 1 would, therefore, assign a white pixel on the coordinate grid where required. This produces a black and white image with no gray.

Eventually, computers were able to read bitmaps to a bit depth of 4. A bit depth of 4 allowed for a total of 16 colors, as 2^4 equals 16. The modern minimum standard for computer-displayed color is a bit depth of 8 or higher. A bit depth of 8, or 2^8, allows for 256 colors. Two hundred fifty-six–color devices are typically handheld devices where graphic quality is not needed. Computer monitors, HDTVs, and other devices that require quality graphics try to achieve true color or deep color.

True color has a bit depth of 24. True color uses the familiar RGB color model with 256 shades of red, 256 shades of green, and 256 shades of blue. True color produces 2^{24} colors, or 16,777,216 colors. Since the human eye is only capable of discriminating a little more than 10 million colors, 24-bit color can result in more colors than the human eye can see. Other color depths above 24 bit fall into the deep color range. ***Deep color*** is supported by Windows 7 up to a 48-bit depth. This provides more intense colors and shadow. Deep color can produce a gamut of over 1 billion colors.

Bit depth also allows for transparency. With a large gamut of color, an alpha channel can be allocated. The ***alpha channel*** varies the opacity of the color. The alpha channel can support from full transparency all the way to full opacity. A 16-bit alpha channel can support 65,536 values of transparency.

Alpha channels can also allow for a masking color. A ***masking color*** is a single shade of a color that can be set to be transparent. If you have ever seen a weather report on TV, you have likely seen a masking color in use. Using a green or blue screen, called a chroma screen, will allow a background of the weather map to digitally replace the blank screen. In image creation, mask colors are typically chosen so they will not interfere with natural colors. Using a masking color such as white would be a very bad choice. If white was made to be transparent, then the white in a person's eyes and other white items would be transparent.

Vector Images

Vector images are images composed of lines, curves, and fills. Vector images do not store the color value and location of each pixel. Rather, the image is displayed based on the mathematical definition of each element in the image. In other words, in a raster image a line is composed of dots, while in a vector image the line is defined by a mathematical equation. For a vector image to be displayed, the software must rasterize the image before it is sent to the display device.

Some software programs can also convert raster images into vector images. This process is called ***bitmap tracing.*** The software will trace around zones that are the same or similar color to create a closed region and fill the region with a color.

A vector image can be a very small file size because the image is drawn by the computer using a mathematical formula. Since the formula draws the image, the image can be resized infinitely smaller or larger without loss of clarity, as shown in **Figure 2-2.** This is one of the biggest advantages of a vector image.

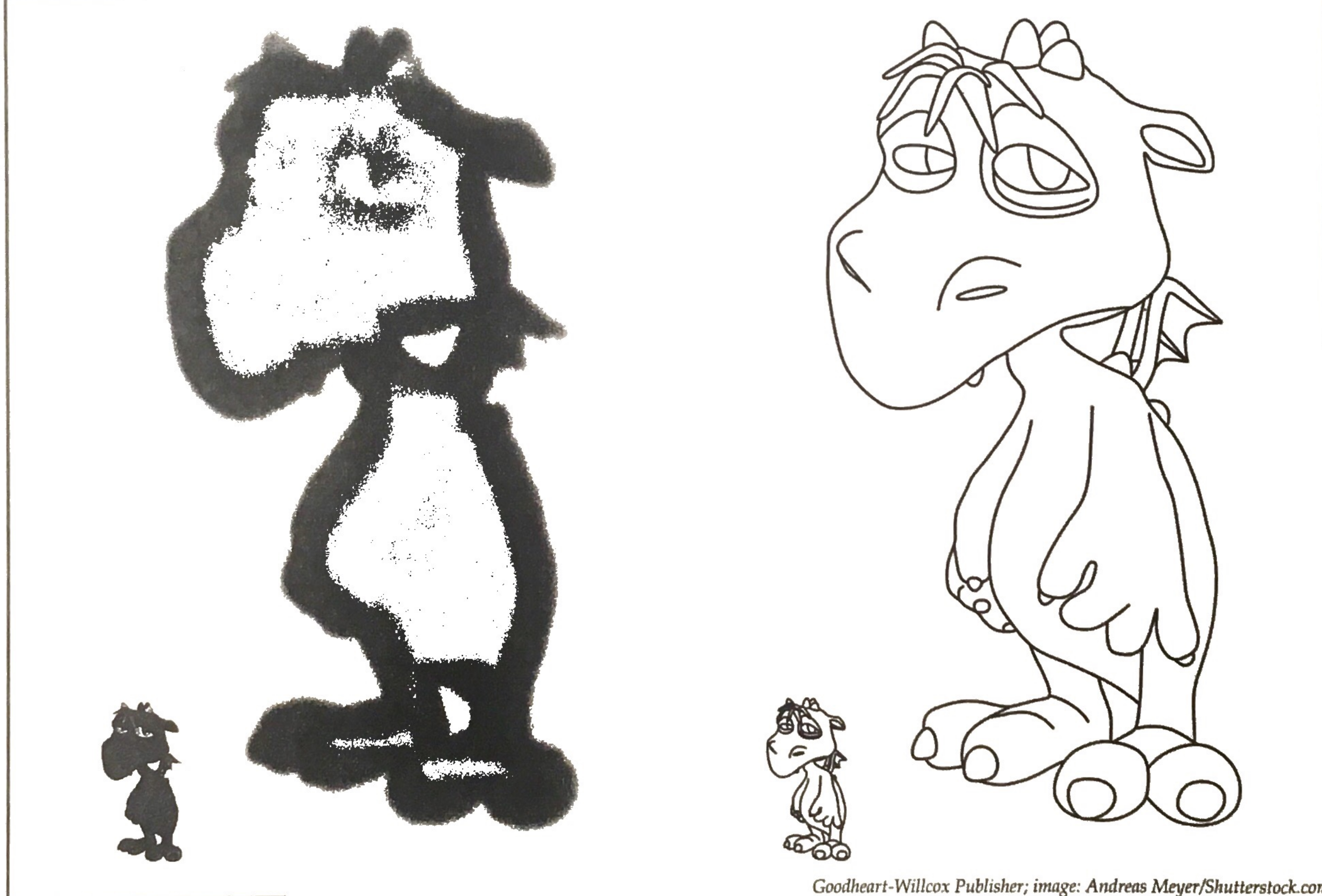

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Figure 2-2.

Raster images become pixelated when enlarged, but vector images can be infinitely scaled.

However, raster images offer an advantage over vector images because a vector image requires the CPU to work hard to draw the image. In the world of handheld devices with small CPUs and low memory, a vector image may have the benefit of a small file size, but may take up a large amount of CPU ability. Bitmaps do not take up a large amount of CPU ability, but have higher file size. The designer will need to understand the limits and capabilities of each device on which the image will be rendered to correctly match the file size and CPU usage to prevent lag and crashing the device.

Image File Compression

When working with images that are used on web pages or mobile devices, a designer should optimize the images. ***Optimizing*** an image is applying the most appropriate resolution and image file compression to achieve the smallest file size for the image quality needed. ***Compression*** uses mathematical formulas to approximate the location and color of each pixel and thereby reduce the total file size. Raster images are often compressed from their original raw format to reduce file size, save computer memory, and decrease download time.

A computer algorithm is used to record the pixel data in a smaller file size and then uncompress the image when it is opened in image-editing software. Almost all compression formats seek to eliminate the color values stored in the image that are beyond the capability of the human eye. The two most popular image-compression algorithms are lossy and lossless. The ***lossy compression algorithm*** compresses the image, but does not keep perfect image clarity. The image generally will have an acceptable appearance, but it will not be as clear when uncompressed as the original image. The ***lossless compression algorithm,*** or losslessly compression algorithm, compresses the image and keeps perfect clarity when uncompressed. There is a tradeoff between clarity and file size. To reduce the file size to run on a handheld device, the clarity may need to be reduced to fit the memory needs of the device and program.

File formats are needed for each type compression so the computer will understand how to read the compressed image. **Figure 2-3** lists several popular image file formats and the compression model needed to expand the image.

Image Sizing and Resolution

When a bitmap image is enlarged, the existing pixels spread out. This ***dithers*** the image, which creates holes in the image where the pixels are no longer touching each other. Dithering can also occur when color is undefined in the program such as a web browser. Software uses a process called interpolation to dither an image. ***Interpolation*** is the refining of the space between pixels. During interpolation, the software averages the color of all pixels touching the empty space. The average color of the surrounding pixels is then assigned to the new pixel.

Part of optimizing a raster image is setting the proper resolution for the intended output. For example, an app for the iPad should have an icon that is 144 pixels × 144 pixels so the icon will properly display on the device and in the app store. On the other hand, most images for print publication should be sized to specific dimensions with a resolution of 300 dots per inch (dpi).

[illegible]	Name	Compression	Benefit
GIF	Graphic Interface Format	Lossless	Popular for use on websites; 256 colors and can be animated
PNG-8	Portable Network Graphic, 8-bit depth	Lossless	Same as GIF, but cannot be animated
PNG-24	Portable Network Graphic, 24-bit depth	Lossless	Same as PNG-8, but more colors and transparency options
JPEG	Joint Photographic Expert Group	Lossy	Generally offers the smallest file size
BMP	Bitmap	Run length encoded (RLE)	Device independent
RAW or CIFF	Camera Image File Format	None	Raw data at full uncompressed value obtained from a digital camera or scanner
CGM	Computer Graphics Metafile	Vector	Can be used with many vector-imaging programs
AI	Adobe Illustrator	Vector	For use with Adobe Illustrator
EPS	Encapsulated PostScript	Vector	Generic vector format that can be used in any PostScript-enabled software

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Figure 2-3.
Common file formats for graphics.

The resolution of an image is measured in ***dots per inch (dpi)*** or ***pixels per inch (ppi)***. This measure is the number of dots or pixels along the horizontal axis of an image multiplied by the number of dots or pixels along the vertical axis of the image. An image that is one inch square with 200 pixels on each axis has horizontal and vertical resolutions of 200 dpi. If this image is stretched to two inches square without resampling, the resolution becomes 100 dpi, which results in a loss of image clarity. If an image with a horizontal resolution of 200 dpi is 5 inches wide, the horizontal dimension contains 1000 pixels (5 inches × 200 dpi = 1000 pixels).

When an image is resized, it must be ***resampled*** to create a new image without reducing the image resolution. Resampling interpolates the image, adding or removing pixels as needed. Most imaging software gives the designer options for selecting a resampling method. A common resampling method is bicubic. There are two variations of bicubic resampling: bicubic for reduction and bicubic for enlargement. *Bicubic for reduction* is optimized for removing pixels, while *bicubic for enlargement* is optimized for creating pixels.

Fonts

A ***font***, or ***typeface***, is a collection of letters, numbers, and symbols that are all of the same design or style. The font can be important in conveying meaning in a design project. Text set in one font may communicate elegance, while the same text set in a different font may communicate excitement or tension.

The two basic designs of font or typeface are serif and sans serif. ***Serifs*** are decorative marks at the ends of letters, as shown in **Figure 2-4.** The word *sans* means without, so ***sans serif*** means without serif. There is much debate over

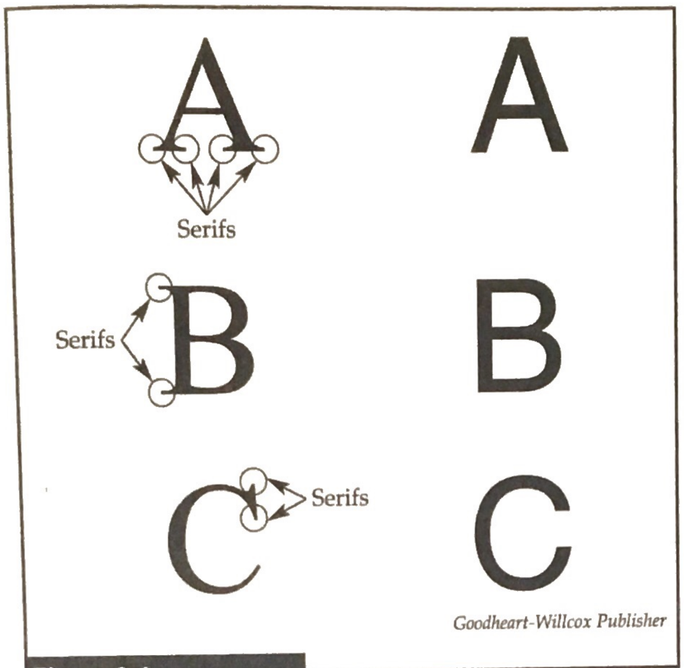

Figure 2-4.
A comparison of serif and sans serif typefaces.

which is more readable. Traditionally, serif type is used for long passages where readability is important, such as books, while san serif type is used when legibility is important, such as street signs. However, there is no clear agreement among experts as to the significance between serif and san serif type when it comes to readability and legibility. It is generally thought that a sans serif type promotes the feeling of security, trust, and strength, which is why this type is typically used in logos and headlines.

Other typefaces that fall outside of serif or san serif classification include novelty, ornate, handwritten, script, and ornamental. These are used as decoration or as an attention item on a page and should not be used when creating the body text. In addition to being hard to read, they may have the added problem of not being installed on the user's computer, which is important in web page design. If a device does not have a specified font, whether decorative, serif, or sans serif, it will be displayed in a substitute font.

Lesson Review

Vocabulary

In a word processing document or on a sheet of paper, list all of the ***key terms*** in this lesson. Place each term on a separate line. Then, write a definition for each term using your own words. You will continue to build this terminology dictionary throughout this certification guide.

Review Questions

Answer the following questions. These questions are aligned to questions in the certification exam. Answering these questions will help prepare you to take the exam.

1. Which color model is used by computer monitors?

 ____

2. Which color model is used for commercial printing of a magazine?

 ____

3. Describe gamut as it relates to color.

 ____

 ____

4. What RGB color bit depth is needed to create 256 colors?

 ____

5. Describe how an alpha channel and masking color control image transparency.

6. Which type of image is composed of lines, curves, and fills?

7. Describe bitmap tracing.

8. Compare and contrast raster images with vector images.

9. What are the two aspects of optimizing a raster image for use on a website or handheld device?

10. How can an uncompressed RAW image file type be obtained?

11. Explain what happens when an image contains a color that is undefined in a web browser.

12. If the resolution of an image is 72 dpi and the image is 8 inches wide by 10 inches tall, how many pixels wide is the image?

13. Which bicubic resampling method is best if enlarging an image from 300 pixels wide to 800 pixels wide?

14. Describe the difference between a serif and sans serif font.

15. Which font design is generally thought to instill trust in the reader?