PRINCIPLES IN TILE DIGITAL PRINTING DESIGNING

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ABSTRACT

The purpose of this article is to show how to design a ceramic tile in the digital printing method and introduce digital printing designing.

In order to do this, it was necessary to go back to the origins of design and study the principles of digital printing.

This article focuses on the basics of quality control in digital printing, color management, color tones and adjustment, image formats, multichannel mode, design correction, modification, calibration and preparation for digital printing.

1. INTRODUCTION

Ink-jet printing is now being increasingly applied to commercial printing and certain features make it particularly attractive for printing in a manufacturing environment. Therefore, it is necessary to learn how to manage a design and color to have a good quality design with low cost in the shortest time.

There are many companies all around the world, especially in Spain, Italy and China, which produce digital printing machinery but in fact, the basis and foundation of all of these is the same. All of the machines have printing heads with approximately the same quality and conditions, a computer for controlling design and connections for data transfer to the printing machine, in addition to some other applications. In this case, we can control and manage printing conditions and design to obtain the best quality and lowest price.

In digital or ink-jet printing, we must know more about the digital image. A digital image is a numeric representation (normally binary) of a two-dimensional image. Depending on whether the image resolution is fixed, it may be of the vector or raster type. In digital printing systems, we always work with raster type formats like TIFF, JPG, PSD, EPS, ….

When we see a picture on our monitor or use our digital camera (or scanner), the image we are viewing or dealing with is not continuous like a pencil drawing – it is made up of many small elements next to each other. When we have enough elements, we get the illusion of a picture or image.

Raster images have a finite set of digital values, called picture elements or pixels. The digital image contains a fixed number of rows and columns of pixels. Pixels are the smallest individual element in an image, holding quantized values that represent the brightness of a given color at any specific point.

Typically, the pixels are stored in computer memory as a raster image or raster map, a two-dimensional array of small integers. These values are often transmitted or stored in a compressed form.

Raster images can be created by a variety of input devices and techniques, such as digital cameras, scanners, designers, and more. They can also be synthesized from arbitrary non-image data, such as mathematical functions or three-dimensional geometric models; the latter being a major sub-area of computer graphics. The field of digital image processing is the study of algorithms for their transformation.

Each pixel is a sample of an original image; more samples typically provide more accurate representations of the original. The intensity of each pixel is variable. In color image systems, a color is typically represented by three or four component intensities such as red, green, and blue, or cyan, magenta, yellow, and black. When we need to have good quality printing, we must have a good image with high resolution. The word pixel is based on a contraction of pix ("pictures") and el (for "element").

In digital printing, we use the terms "DPI" for resolution. DPI (dots per inch) is a measurement of printer resolution, though it is commonly applied, somewhat inappropriately, to monitors, scanners and even digital cameras.

For printers, the DPI specification indicates the number of dots per inch that the printer is capable of achieving to form text or graphics on the printed page. The higher the DPI, the more refined the text or image will appear. To save ink, a low DPI is often used for draft copies or routine paperwork. This setting might be 300 or even 150 DPI. High resolution starts at 600 DPI for standard printers, and can far exceed that for color printers designed for turning out digital photography or other high-resolution images. In the case of monitors, DPI refers to the number of pixels present per inch of display screen. The technically correct term is "PPI" or pixels per inch, but DPI is commonly used instead. A display setting of 1280 x 1024 has 1.3 million pixels on the screen, while a setting of 800 x 600 has 480,000, or less than half the resolution of the higher setting. With fewer pixels, the picture will not have the clarity that can be achieved with a higher saturation. Each dot or pixel reflects a certain color and brightness. The greater the number of pixels, the more detailed the picture can be. More pixels also require more memory, and it can take longer to "paint" images, depending on the system's video card, processor and other components of digital printer. Therefore, if you need to work in a glazing line with a high speed to increase the quantity of tiles, you need a printer machine that can handle your line speed without decreasing the image resolution.

The past few years have seen a boom in the number of companies offering new printers based on inkjet printing technology for ceramic tile decoration. Therefore, the operator or technician of Tile Company must have information on design software, spectrophotometer, color profile, test chart and so on, rather than on other features such as firing temperature, glaze defects and so on.

The basic principles which it is necessary to know are divided into three sections:

- Use of color profile.
- Graphic treatment in Photoshop.
- Image preparation for printing.

2. ADVANTAGE OF THE DIGITAL PRINTING DESIGN METHOD

Before digital printing, in the traditional method, tile development depended on color preparation and screen printing on laboratory. For any new design, technicians mixed pigments with printing powder in constant proportions to achieve a desired color after firing. They applied design with screen printing to print a sample. Then for rotary printing, a test band would be prepared to test the effect of engraving and design with the cylinder. If all previous steps were performed correctly then a complete engraved cylinder had to be ordered and industrial test of the design started in the glazing line. But in the digital printing method, all of the previous steps are eliminated and there is no need to prepare and mix colors in laboratory and doing so many tests to prepare a design.

3. QUALITY CONTROL AND TEST CHART IN DIGITAL PRINTING

For controlling intensity of the color in digital printing, the spectrophotometer is used more than visual control by the human eye. ISO 12647-2 standards of offset printing nowadays is using for controlling ΔE, ΔL*, $\Delta_{density}$ but a specific ISO standard for digital printing would be essential.

A test chart is a combination of colors and designs to help control any digital printing defects during production. To compare a tolerance between colors in industrial production the test chart background chosen was gray in CMYK mode with Cyan 25%, Magenta 19%, Yellow 19% and Black 20%. These are the four ink colors used in the digital printing method. The three colors, plus black, roughly correspond to the primary colors, from which colors can be mixed across the visible spectrum. CMYK is a color mixing system that depends on the pigments to achieve the desired hues. By using this combination of colors for the test chart background, any defects in uniformity of colors will show up more clearly because human eyes can recognize details better in this kind of gray tone.

Image 1. Test charge sample to control color intensity by eye.

3.1. DARK TONES AREA

In the test chart there is a section for dark and light tones. Details in the dark and light tones must be recognized in the test charge to evaluate any changes in color intensity during production. Details of the dark tones and any changes during production can be recognized by comparing section B and G in image 1, in the samples during production. If we have a problem in calibration of the machine, it can recognized by comparing these sections.

In digital binary machines the size of the ink drops is the same during printing, but in the grey scale mode and the DOD printhead nozzles the size of the inks drops can be varied. Using DOD printheads, more quality can be achieved than binary systems. If the dark tones area has a big surface, it is better to use large-size drops to cover the surface, but in the images with an elegant area with details in the edge, good quality can be achieved by small-size drops.

3.2. LIGHT TONES AREA

Separation in the color chart is for a better reorganization in any color shades that might be caused by changes in the ink batch properties or conditions and operation of the digital machine and heads. In image 1, section C and E, the details in the light tones can be compared. It is very hard to recognize any changes in light tones area by spectrophotometer, but by test chart control this can be distinguished.

3.3. COLOR MANAGEMENT

The test chart is a useful tool for color management. It can be used to achieve maximum color intensity by a minimum quantity of the inks. For example if by 60 percent of total potential of the printheads and maximum grey scale, the sample is the same as 70 percent, it is not recommended to use the inks in the upper levels to optimize ink consumption during tile production and reduce production costs. The test chart can also be used to recognize details of the tile design. For a good result, it is better to use a suitable drop size for a color in a design with precise details or design with low and soft details; therefore, it is important to take care regarding the kind of tile details in tile digital designing.

For each color bar in the digital printing machine, there is sphere in the test chart to control any linear displacement of each color adjustment. Any gap or overlapping in the color sphere edge or uncompleted color sphere is a reason for a problem in tile printing adjustment. In image 1 there are four sphere color tests for cyan, magenta, yellow and black and also one sphere for the total of all colors to control overlapping of all colors.

4. PRINCIPLES IN MAIN COLOR MODELS FOR DIGITAL PRINTING

It is necessary to know about main color models in software such as Photoshop for design preparation. The main color models are GIE LAB, RGB, CMYK and HSB. By running Photoshop software and clicking on color picker tools in the main tool bar, all color models can be seen. In image 2, all the color models are shown in the Photoshop software.

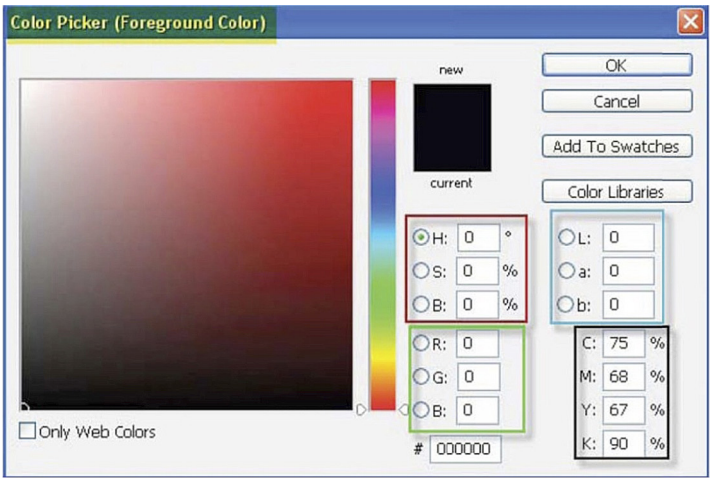

Image 2. Main color model parameters in Photoshop.

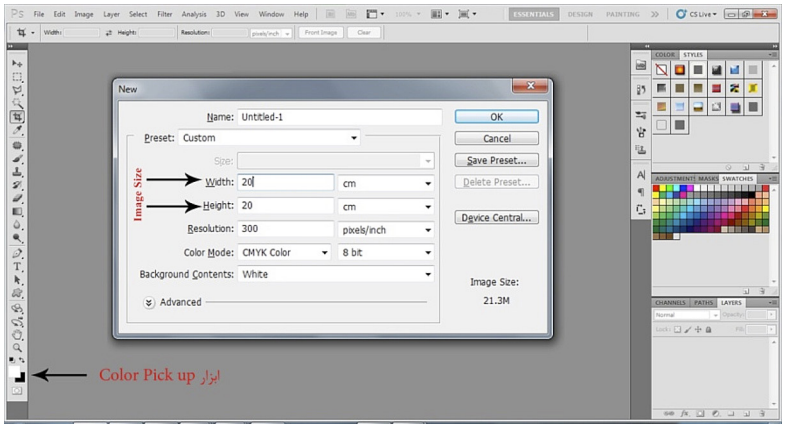

Image 3. Working with a new image in Photoshop and choosing the color mode and design size.

The RGB color model is an additive color model in which red, green, and blue light are added together in various ways to reproduce a broad array of colors. The name of the model comes from the initials of the three additive primary colors, red, green, and blue.

The main purpose of the RGB color model is for the sensing, representation, and display of images in electronic systems, such as televisions and computers, though it has also been used in conventional photography. Before the electronic age, the RGB color model already had a solid theory behind it, based on the human perception of colors.

The CMYK color model (process color, four color) is a subtractive color model, used in color printing, and is also used to describe the printing process itself. CMYK refers to the four inks used in some color printing: cyan, magenta, yellow, and key (black).

In additive color models such as RGB, white is the "additive" combination of all primary colored lights, while black is the absence of light. In the CMYK model, it is the opposite: white is the natural color of the paper or other background, while black results from a full combination of colored inks. To save money on ink, and to produce deeper black tones, unsaturated and dark colors are produced by using black ink instead of the combination of cyan, magenta and yellow.

HSL model stands for hue, saturation, and lightness, and is often also called HLS. HSV stands for hue, saturation, and value, and is also often called HSB (B for brightness). A third model, common in computer vision applications, is HSI, for hue, saturation, and intensity.

In each cylinder, the angle around the central vertical axis corresponds to "hue", the distance from the axis corresponds to "saturation", and the distance along the axis corresponds to "lightness", "value" or "brightness". Note that while "hue" in HSL and HSV refers to the same attribute, their definitions of "saturation" differ dramatically. Because HSL and HSV are simple transformations of device-dependent RGB models, the physical colors they define depend on the colors of the red, green, and blue primaries of the device or of the particular RGB space, and on the gamma correction used to represent the amounts of those primaries. Each unique RGB device therefore has unique HSL and HSV spaces to accompany it, and numerical HSL or HSV values describe a different color for each basis RGB space.

Both of these representations are used widely in computer graphics, and one or the other of them is often more convenient than RGB, but both are also criticized for not adequately separating color-making attributes, or for their lack of perceptual uniformity. Other more computationally intensive models, such as CIELAB or CIECAM02 better achieve these goals.

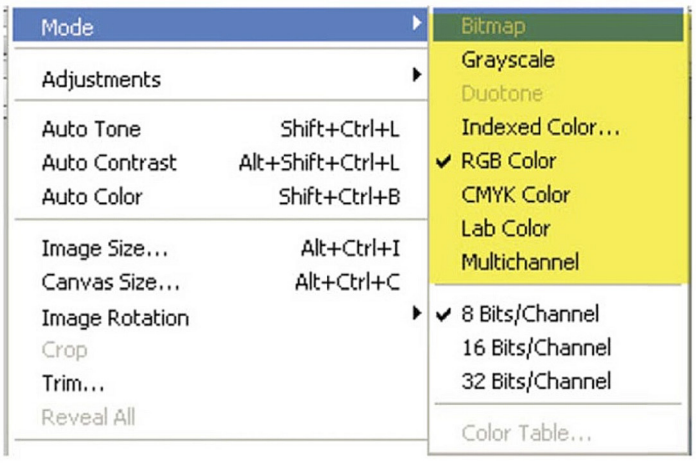

Imagen 4. Modos diferente de color para el diseño en Photoshop.

In photography and computing, a grayscale or greyscale digital image is an image in which the value of each pixel is a single sample, that is, it carries only intensity information. Images of this sort, also in Photoshop known as black-and-white, are composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest.

In grayscale mode there is a color tolerance between 0 and 255. In this case 255 means complete white and 0 is complete black. It can be used for digital printing system if there is needed to use all channel of inks in same condition in printing as the others.

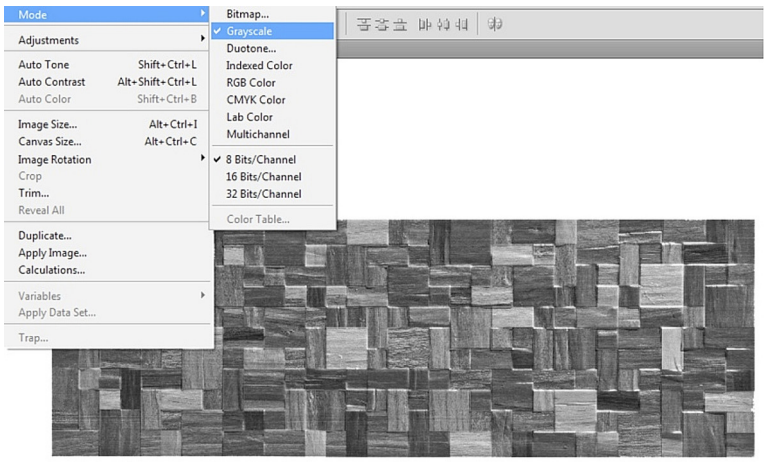

Image 5. Grayscale mode for black and white color.

5. ACCEPTABLE FORMATS FOR THE FILES

One can start with camera-digitized originals with the possibility of obtaining RAW format images or use scanners, obtaining TIFF documents. The main difference between these formats is that the RAW image is a digital image file format that contains all the image data as captured by a camera's digital sensor. When shot in RAW, the camera performs no post-processing, since it only stores the information in memory.

When photographing in RAW, one has greater control of image appearance: it is possible to correct aspects such as exposure, white balance, contrast, saturation, and the calibration of the different color channels, all without any information loss. In order to be able to make these adjustments, specific software is required to process the RAW files by means of digital development and to convert them into TIFF files for subsequent printing.

6. IMAGE PREPARATION FOR DIGITAL PRINTING

If the file is in RGB mode, to see a better result and have less difference in the image which you can see on the monitor and on the tile, it is recommended to convert it to CMYK mode and use the gamut warning to reduce any change of design. To apply gamut warning use this address in Photoshop:

Edit>menu>preference>transparency&gamut

The size of the design file, resolution and dpi of the image, profile output, etc. influence tile design preparation. After processing the RAW file, it must be saved as PSD, TIFF formats which have no defect in tile design quality.

To adjust a color intensity of each channel of design it is recommended to use the Levels or Curves mode in Photoshop. To use these tools, choose image, then adjustments and then the levels or curves mode. Shortcut keys, such as ctrl+L for levels, and ctrl+M for curves, can be used.

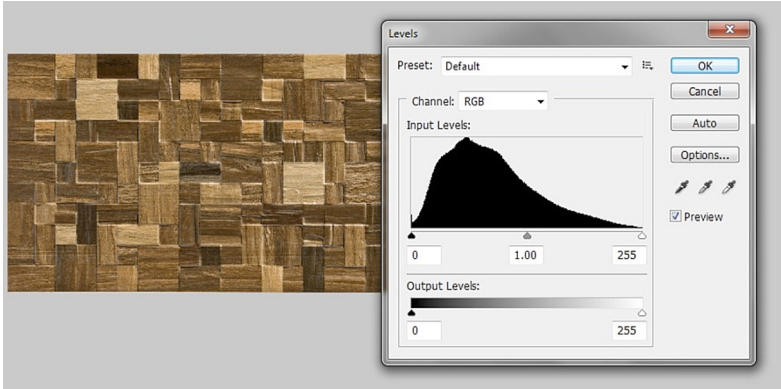

Image 6. Levels mode control in Photoshop.

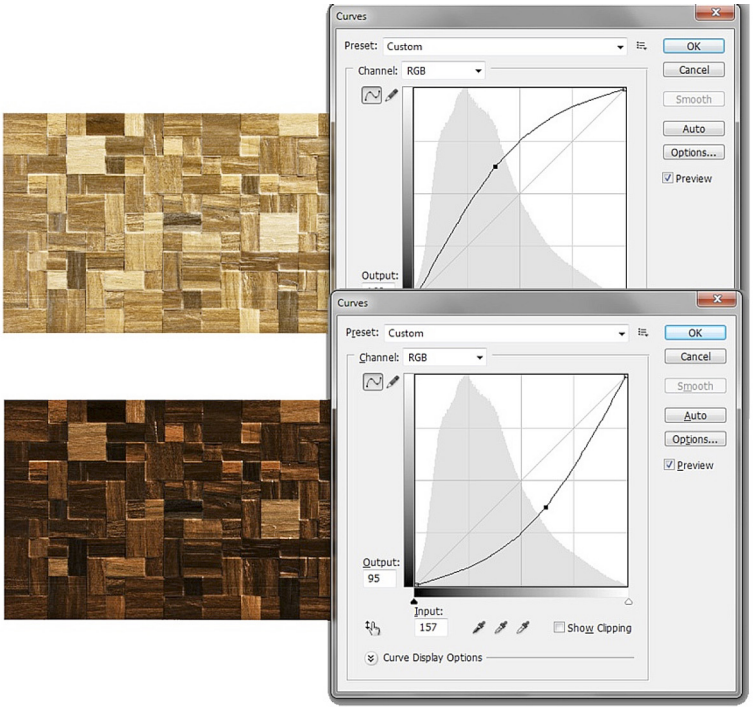

Image 7 - Curves mode control in Photoshop.

Similar to Photoshop levels, the curves tool can take input tones and selectively stretch or compress them.

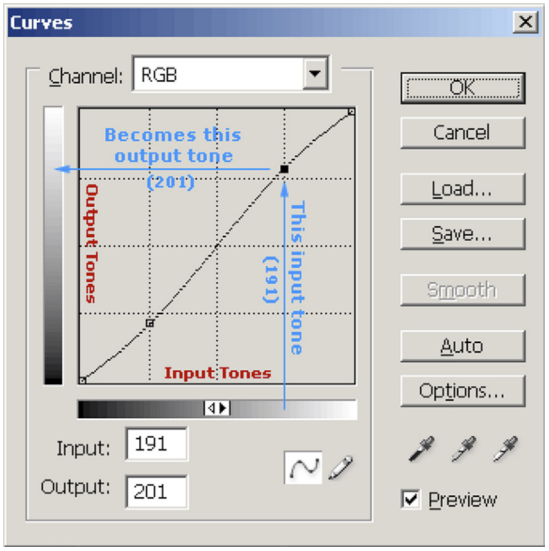

Image 8. The curves mode adjustment.

With the curves tool there are 16 control points and in the levels mode there are 3 control points. The Photoshop curves tool is perhaps the most powerful and flexible image transformation, yet it may also be one of the most intimidating. Since photographers effectively paint with light, curves is central to their practice because it affects light's two primary influences: tones and contrast.

Unlike levels however, which only has black, white and midpoint control, a tonal curve is controlled using any number of anchor points (small squares below, up to a total of 16). The result of a given curve can be visualized by following a test input tone up to the curve, then over to its resulting output tone. A diagonal line through the center will therefore leave tones unchanged.

If you follow two spaced input tones, note that their separation becomes stretched as the slope of the curve increases, whereas tones get compressed when the slope decreases (compared to the original diagonal line). Recall from the image histogram tutorial that compressed tones receive less contrast, whereas stretched tones get more contrast. Move your mouse over the curve types below to see how these changes affect this exaggerated example:

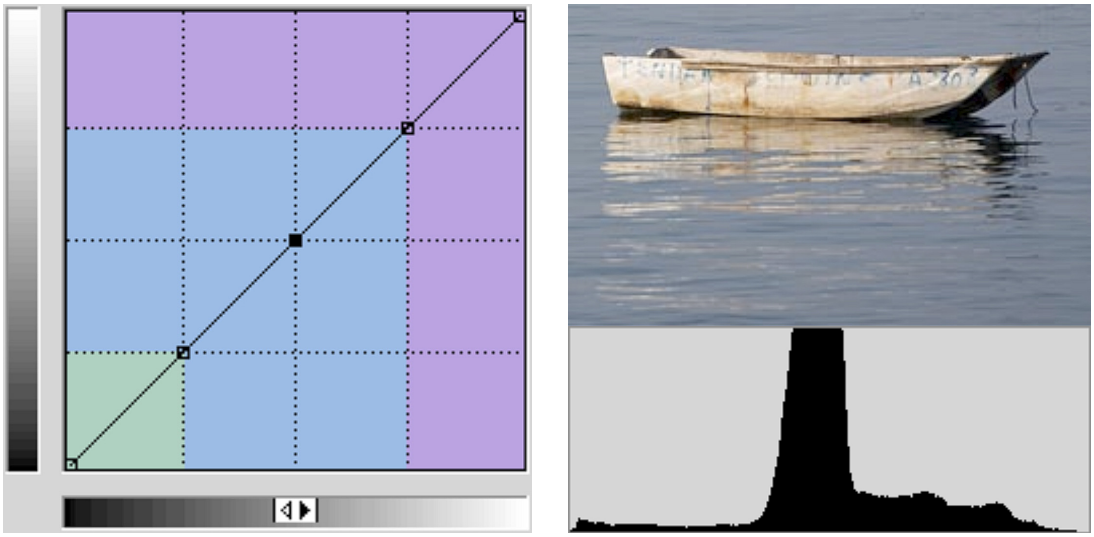

Image 9. Curves and histograms shown above are applied to and shown for luminosity (not RGB).

The curves shown in image 9 are two of the most common: the "S-curve" and the "inverted S-curve." An S-curve adds contrast to the midtones at the expense of shadows and highlights, whereas the inverted S-curve does the opposite. Note how these change the histogram and most importantly, also notice how these changes influence the image: the reflection detail on the side and underside of the boat become clearer for the inverted S-curve while water texture becomes more washed out (and the opposite for the S-curve).

7. SOME KEY POINTS IN DIGITAL PRINTING

7.1. It is essential to choose a design for digital printing with high quality which it is not possible to produce with the other printing methods. The chosen image must have at least 300 dpi resolution.

7.2. Before selecting your image to produce it with a digital printer, it is necessary to see your test chart color to be sure that it is possible to obtain these color tones by printing. There are many suitable software programs to check the design and study the feasibility of digital printing systems. You can ask your machine supplier for this kind of software.

7.3. To compare samples during production, it is necessary to prepare the same conditions in tile production. Kind and weight of the glaze, engobe, firing temperature, kiln cycle, etc. must be the same in the reference and in the new sample.

7.4. To select an ink for a digital printer machine it is better to choose an ink with higher intensity, in order to use a lower quantity of ink during production to achieve a given tonality.

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