Planet of-tunes

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Colour issues

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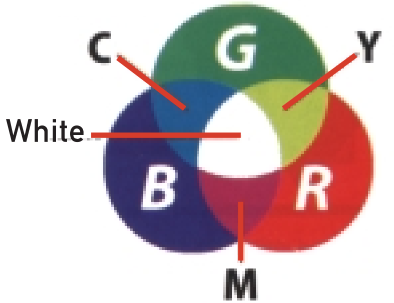
CONTENTS

Introduction

The processes by which computers display colour and output devices (such as printers) reproduce it are complex and problematic. Unfortunately graphic designers and multimedia developers must understand these processes if they are to control the way their projects print and display on differing end-user systems.

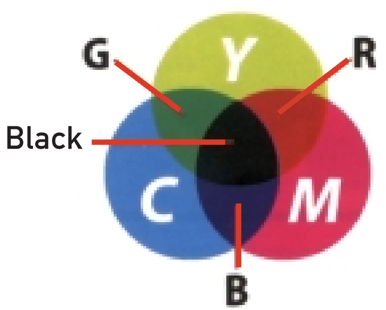
RGB Colour



Computer screens handle colour differently from printers. Screens use light and printers use ink.

RGB (Red, Green, Blue) is the colour model for the screen. Mixing light to create different colours is subtractive. Focus the light from a red, a green and a blue torch together and you will get white light. Images created on-screen and intended for use on-screen in multimedia productions or web pages should be saved in RGB mode.

CMYK Colour



CMYK (Cyan, Magenta, Yellow, and Black) is the colour model for combining inks together during printing and is additive. By combining these four colours together in different amounts a vast range of colours can be printed. Images created on-screen which are intended for print must be converted to and saved in CMYK mode.

Indexed Colour mode is the colour model for GIF images in which a special (Adaptive) pallet is created containing only the colours present in the image.

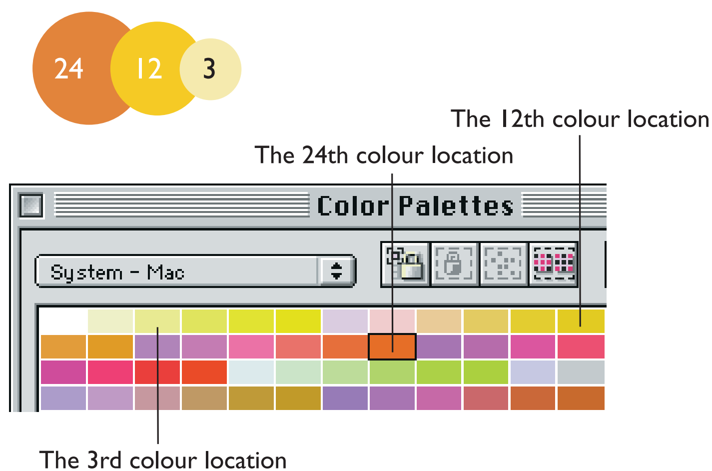
Colour bit depth

The number of colours a computer system can display is a function of the systems colour bit-depth which in turn depends on the capabilities of the screen and graphics hardware. Colour bit-depth is measured in Bits Per Pixel (or Dots).

The colour of every pixel displayed on a screen is chosen from a table of pre-defined colours called a Palette, or on the Macintosh a CLUT (Colour Look-Up Table). *For the purpose of coherence both Palettes and CLUTs will hereafter be referred to as Palettes.*

These palettes have a number of "locations" each identified by a unique number and filled with a unique colour. Each pixel is mapped to one of these locations and the colour which occupies it determines the pixel's colour.

CLUT (Colour Look-Up Table)
A simple image and the palette colour locations to which its pixels are mapped



The number of palette locations, and therefore available colours, depends on bit-depth. The simplest palette would have a bit depth of 1 and contain two locations, one occupied by white and the other by black. Therefore the colour of each pixel in a black and white image would be determined by a single digit, either 0 or 1.

A more complex palette might have a 16-bit colour depth containing 32,768 colour locations. Therefore the colour of each pixel in an image drawing its choice of colours from such a palette would be determined by a 16 digit number, between 0000000000000000 and 0111111111111111.

Bit depth	**Colours in image**	**Image type**	**Good for**
1 bit	2 (black / white)	Line art	Multimedia / Web
(Under) 8 bit	216	Web safe	Multimedia / Web
8 bit	256	RGB	Multimedia / Web
16 bit	32,768	RGB / CMYK	Multimedia / Repro
24 bit	16.7 million	RGB / CMYK	High end Repro

Different computer systems have different colour bit-depth capabilities. In the early 80s the first personal computers were only capable of 1-bit depth and therefore had black and white screens. The Windows 3.1 operating system is still widely used and only supports 8-bit. Current computers are capable of 24 or even 32-bit colour depth allowing for millions of colours.

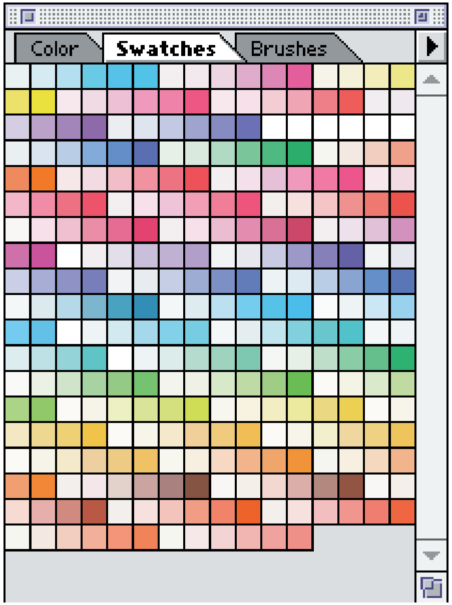
Dithering

If the colour bit-depth capability of a computer is lower than the colour bit-depth of an image it is trying to display it will "re-map" the colour of every pixel in the image to the closest equivalent colour in its own Operating System Palette, with unpredictable results. This process of re-mapping is known as Dithering. Clearly, if you wish to avoid re-mapping, the bit-depth of your images must not exceed that which your end-user's hardware is capable of.

The three leading operating systems (Unix, Windows, and Mac operating system) use simple 8-bit system palettes (allowing 256 colours) to display icons and windows etc. However, only 216 of these colours are common between them. A palette containing only these 216 colours is commonly referred to as a Web Safe Palette.

If you specify colour from the web safe palette you can be certain that they will not be re-mapped whatever computer they are displayed on. Of course if the hardware supports higher bit-depths, operating system palettes won't be employed for re-mapping anyway.

Web safe palette
A palette containing the 216 colours shared by Unix, Windows and the Mac operating systems.



Colour for multimedia & the web

Anticipating end-user colour bit-depth

We can now see that developers must always attempt to anticipate the colour bit depth specification of the end-user's system. Here are some helpful guideline (as of August 1999) for the prudent developer:

- Unknown minimum end-user system. A prudent developer will specify colour from the web safe palette.
- Current domestic end-users. If you want to ensure your multimedia will be viewable by most domestic end-user's use 8-bit colour palettes.
- Business end-users. You may safely assume that most business users will have higher spec computers capable of displaying 16-bit colour depth.
- High end known end-users. Use 24-bit colour depth only when you are certain of your end-user's hardware, for example if you are developing for an intranet or kiosk installation.

If you author using 8-bit colour depth exclusively you can instruct a Director projector to interrogate and reset the end-user's colour bit-depth to 8-bit to ensure smooth running of your project if you wish.

Choosing colour bit-depth

Images which draw their colours from high bit-depth palettes will have larger file sizes than those which use lower bit-depth palettes. They therefore suffer from the following disadvantages:

- They will require more RAM memory when displaying.
- They will require more disk or CD-ROM storage space.
- They will load into memory more slowly from CD-ROM perhaps causing your project to pause.

- They will animate more slowly on slower systems as the computers graphics processor works to process and redraw the image on the screen.

For multimedia work it is therefore desirable to choose a palette with as low a bit-depth as possible even if the end-user system is capable of high bit depth display.

Using low colour bit-depths is particularly important when creating images for the web for 2 additional primary reasons:

- Download time. Small file sizes will ensure faster download times.
- Dithering. Because the end-user's computer bit-depth is unknown you will be unable to anticipate how the colour of your images will display in their browsers.

It may interest you to know that the BBC runs two web sites. One is built to "corporate" specifications for up to date end-user systems whilst the other will run on a modest 486, version 2 browser, no plug-ins, 28.8Kbps modems, 8-bit etc system.

Bit depth	**Colours in image**
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256

Problems with multiple palettes

Within a multimedia project it is perfectly possible to have multiple images each drawing their colours from a unique optimised palette. However, it is desirable to have all your images share a custom palette (called a Super Palette in DeBabelizer) for 2 principal reasons:

- Palette flashing. In Director, if each on screen image employs a unique 8-bit palette, and your project is running on a computer only capable of displaying 8-bit colour, every time the image (and therefore the palette) changes the screen will flash. Nasty!
- Multiple simultaneous images. Computers can only display using one palette at a time. Therefore you will not be able to have multiple images, each with their own palette, on screen simultaneously without re-mapping taking place.

Specifying a shared palette

Once you have profiled your end-user and determined a suitable colour bit-depth you will need to determine an optimised shared palette for all your images. There are a number of ways to do this.

- Choose an existing palette (such as a system or web safe palette) or create a custom palette in your image creation/editing applications and specify all your colour from it.

- Completely disregard colour issues as you download, scan, create or edit your images, then prior to importing them into your authoring application batch process them with an image optimising application such as Graphics Convertor, Fireworks, Image Ready or DeBabelizer. These programs can analyse multiple images, build an optimised "custom" palette to a user defined bit-depth, and remap all the colours in the images to it. Incidentally Director can also do this but less effectively.

DeBabelizer can also remap every colour in every frame of a QuickTime video clip.

• In Indexed colour mode Photoshop can create an Adaptive Palette from any image. Adaptive palettes contain only the colours in the image from which they are derived. Such a palette can be saved independently of the image and other images re-mapped to it. If you create an adaptive palette from an image, and then import the image into Director, the palette will take up its own position in Director's Cast window. Internally created cast members may then be remapped to it also.

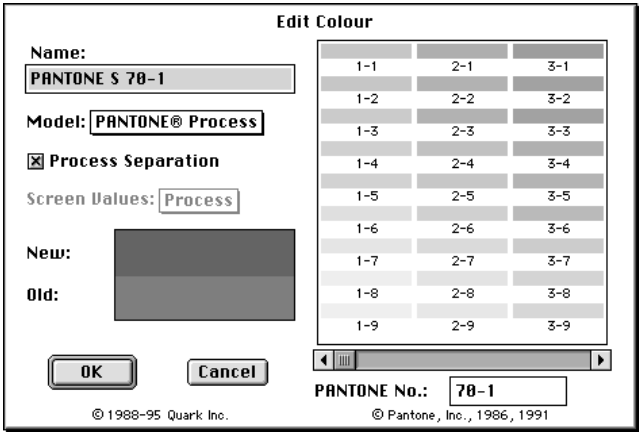
It's worth mentioning that Director developers who employ Ink Effects to alter the colour of sprites will be generating "free" additional colours not necessarily defined in any cast or system palette.

Colour for print

Computer screens do not accurately display ink equivalents and so cannot be relied upon to display an accurate preview of the final printed colours irrespective of whether the image is on-screen in RGB or CMYK mode. Therefore the colour balance of pixel based images must be checked in proofing. When specifying colour for text, line art, and vector based images intended for print we must refer to a printed colour chart. Two basic method are used:

Process Colour requires four printing plates, one each for printing Cyan, Magenta, Yellow and Black. When a finished artwork is output for printing to an image setter, four film separations are made from which four printing plates are made. This is the standard printing method for colour.

QuarkXpress colour dialogue box



In QuarkXpress you can specify Process Colour from a CMYK Pantone Process palette whilst referring to a printed version. You may also specify Process Colour with any other CMYK Process Colour chart, providing it specifies the precise colour balance of the four inks, by entering their percentage values into Quark's colour specify dialogue box.

Spot Colour inks are mixed according to specifications defined in a different colour matching system and require an additional printing plate. Spot colours cannot be achieved by mixing CMYK. Therefore, using spot colour will add to the cost of printing.

If you import a vector image into QuarkXpress that contains colour not specified using a Process Colour pallet, Quark will add the colour to the list of colours specified for the artwork as a spot colour. When the job is sent for output an extra colour separation will be made requiring an additional plate.