Merv Moriarty answers frequently asked questions about the colour wheel for painters and designers

Q: why should I have a colour wheel?

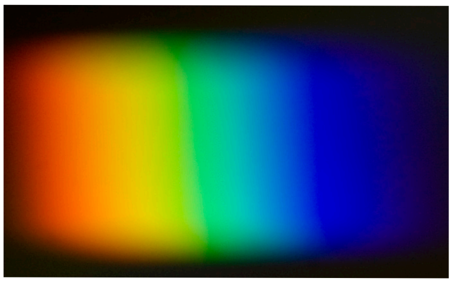
A: a good colour wheel allows you to see all colour hues in a perfect and natural organisation. It shows the relationship between primary colours, secondary colours, complementary colours, etc.

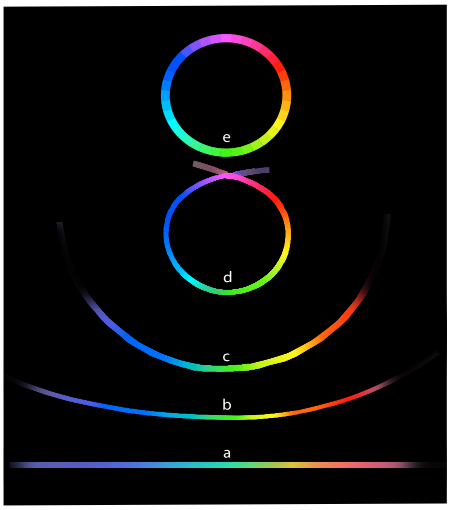
The Moriarty Three-Section Colour Wheel is specifically designed for colour mixing in pigment or dye stuff.

Q: is there any meaningful order to the way the colours are arranged in a "good" colour wheel, or is it simply someone's opinion?

A: it took a long time for scientists and researchers to get the arrangement of the colour wheel right and some of the earlier ones simply don't work effectively. The best colour wheel arrangement evolved directly out of the structure of light itself and human colour vision:

The Moriarty Three-Section Colour Wheel is a new principle. The division of the colour wheel into three sections allows us to determine the shape (path) two colours will take when mixed together. Combinations within a section will remain pure. Combinations of colours from different sections follow a different path; the curve of this path becomes increasingly straighter the further apart the colours are from each other on the wheel; the Moriarty Colour Wheel & Mixing Plotter shows this instantly.





a: a thin strip through the spectrum - could be imagined as a rope made of light.

b: perhaps we could pick this up at the two ends.

c: lift the two ends higher

d: cross the ends over each so that the blue end blends with the red end - magenta appears where they cross.

e: we have a rhudimentary colour wheel.

Q: how did the colour wheel evolve?

A: the colour wheel starts with the spectrum, or rainbow. As you would know, a spectrum is created when light passes through a prism, which bends the wavelengths to different degrees depending on the length of the wave.

The longest wave length is red, the mid length is green and the shortest is blue. If we look at this spectrum starting from one end, say the red end, the colour gradually changes from red to orange, to yellow, to green, to cyan and finally blue after which there is no more colour.

Q: what colour is missing?

A: the colour is magenta.

Although the spectrum represents all colour generating wavelengths, one important colour is missing. This colour is commonly seen in nature and in design.

Q: if magenta is not in the spectrum, how do we see it?

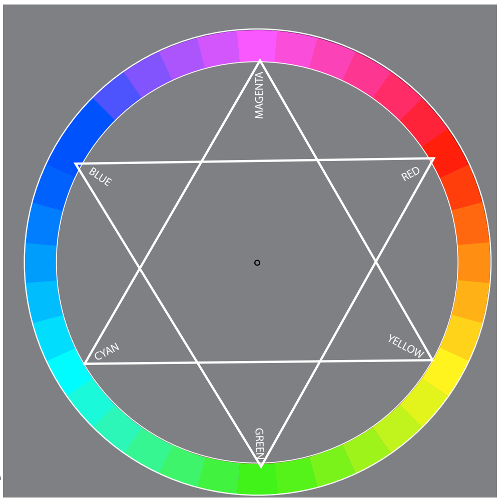
A: the answer to this question provides the key to the structure and importance of the colour wheel; imagine the spectrum as a rope made of light with all spectrum colours from red on one end to blue on the other – green in the middle.

If we cross the Red end over the Blue end – magically we create Magenta and the connecting range of colour either side of magenta. So we now have a hoop of coloured light that includes all pure (saturated) colour perceivable by us (as light).

But there is more to do to our rope/hoop of coloured light before it can be considered a good colour wheel. Every point on the circumference of the wheel must be exactly in the right place.

- the three primary colours of light (red, green, blue) must be 1/3 of the circumference of the wheel apart. Equal strength combinations of these three colours, as light, will produce white light (that is total light).
- the three primary colours of pigment should also be there and 1/3 of the wheel apart placed so that the

points of the pigment primaries are mid way between the primaries of light as in the diagram right.



- every point on the circumference of the wheel must be exactly opposite its complementary.

Q: what does complementary mean when we are talking about colour?

A: complementary colours make white when combined as light and black when combined as pigment. I now explain this further.

Our perception of colour is not the response to a single beam of light of a particular colour (as was once thought) it is our response to the colour that dominates the field of wavelengths we are experiencing.

So when we experience yellow we are also visually exposed to its components: Red and Green. That is; in a dark space, a red light projected onto a white screen will show a red spot – a green light will make a green spot – if they are both projected onto the same place the result will be a yellow spot. If we now project a blue light (also onto the same place) the result will be a white.

Therefore: if we remove yellow from a beam of white light we also remove Red and Green. Blue is now all that is left of the white light. The remainder is now missing. If we return the yellow light, which represents the remainder of white light, we return to the total (the full complement, white).

Therefore: Yellow and Blue are complementary colours. The yellow provides the red and green and blue is the only remaining primary colour (of light). When they are mixed together as pigment they make black which is the absence of all colour. This is because pigment does not project colour from itself. It selectively absorbs wavelengths of light from the white light falling on the pigmented surface and reflects the remainder back.

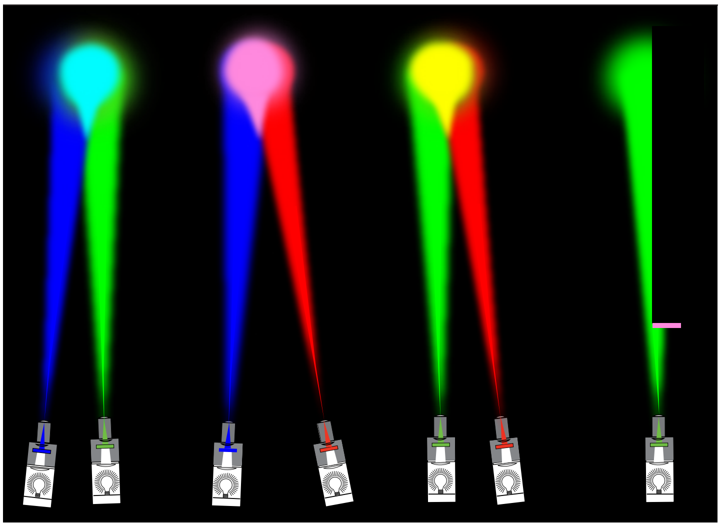
Mixtures of pigments are called subtractive, that is, they collectively absorb (subtract) from the white light. Mixtures of colour as light are called additive because two light sources, for instance two or more projectors are required.

Q: how many primary colours are there?

A: many people would of course say three: red, blue and yellow, but this would be quite wrong. There are three primary colours of light – Red, Green and Blue and three primary colours of pigment – Cyan, Magenta and Yellow. So we can say that there are, in total, six primary colours, three of light and three of pigment.

As shown right -

- When we mix colours in light, as we do on a computer using RGB, a combination of Red, Green and Blue (the primary colours of light) can be used to make any colour.
- Red and Green gives us Yellow and Blue and Green gives us Cyan whilst, as seen with the ends of the spectrum, Red and Blue make Magenta.
- Combinations of two primary colours of light ie: Red and Green create the secondary colours of light ie: Yellow.
- The secondary colours of light are the primaries of pigment, and visa versa.
- Three primary colours are absolutely all we need when working on a computer in RGB (light).
- When we work with pigments the principle of three primaries is theoretical and does not exist in reality because pigment makes colour by absorbing wavelengths selectively from the totality of white light and pigments are not 100 % effective. Therefore we need a greater range of colours for good colour control.



Q: why do printers use CMYK?

A: because the printing industry has to make do with the minimum of colours (hues) used to make a complete looking colour picture they have to limit themselves to the best possible choice of pigments to achieve this. They chose a pigment to represent cyan (C) – a pigment to represent magenta (M) – and a pigment to represent yellow (Y) - plus black (K). There are very good pigments to represent yellow, but pigments representing cyan and magenta have some limitations so printing in the so-called four-colour process (CMYK) has to make some compromises.

Q: how many colours do artists need?

A: artists and designers (also printers using a spot colour) do not need to limit their palette and can use a wide range of pigments to get virtually any colour they choose.

Q: can I use a colour wheel to help me mix colours?

A: yes. A well-structured colour wheel (such as the Moriarty Three-Section Colour Wheel) has all hues on the outside edge progressing in equal steps around the full 360 degrees of the compass.

All hues are aligned across the wheel with their complementary. The centre of the wheel is neutral.

Many years ago I recognized that if I divided the colour wheel at the three primaries of pigment: Cyan, Magenta and Yellow, into three sections representing the primaries of light: Red, Green and Blue, I could define clearly a mathematically correct pathway between combinations of colours depending on their position on the wheel relative to the three sections.

- Colours mixed together in one section of the wheel remain relatively pure.
- If colours are mixed from two sections, some of the complementary colour is introduced and the colour is less pure (greyer). It is mathematically constant and predictable.

This lead to creating the Three-Section Colour Wheel, which in turn enabled me to 'plot' the paths of mixing two colours together.

I then developed the Moriarty Colour Mixing Plotter, which we are now producing.

Q: how does the Moriarty Colour Mixing Plotter work?

A: the Plotter plots the results of mixing any two colours. This enables you to decide which pigments you wish to use to mix any colour. You can use favourite pigments or if you have a colour on your palette, you can work out what to add to make a new colour – and save wasted paint.

Q: why shouldn't I use black or Paynes grey to make my colours less pure?

A: the addition of black or Paynes grey results in colours without life; they remain disconnected from the rest of the painting or design.

Alternatively, for example, by using vermilion and viridian, you will make a wonderful range of greys which then resonate with your colour scheme. As well as this, by using colours to produce greys and blacks or to darken colours you are mentally connected with colours in their relationship to each other as a whole. This is critical to your understanding of colour.

So it's back to the first question about why we need a colour wheel and my answer –

When we are using colour it is not the individual colour that matters, it is the relationship between colours.

I cover colour relationship in depth in my book *COLOUR - the definitive guide*.

If you have other questions please send me on my Face book page, or via my web site, www.mervmoriarty.com

Thanks for your questions,

Merv Moriarty