THE RAINBOW

Box Art Group Newsletter - Friday 25th November 2022

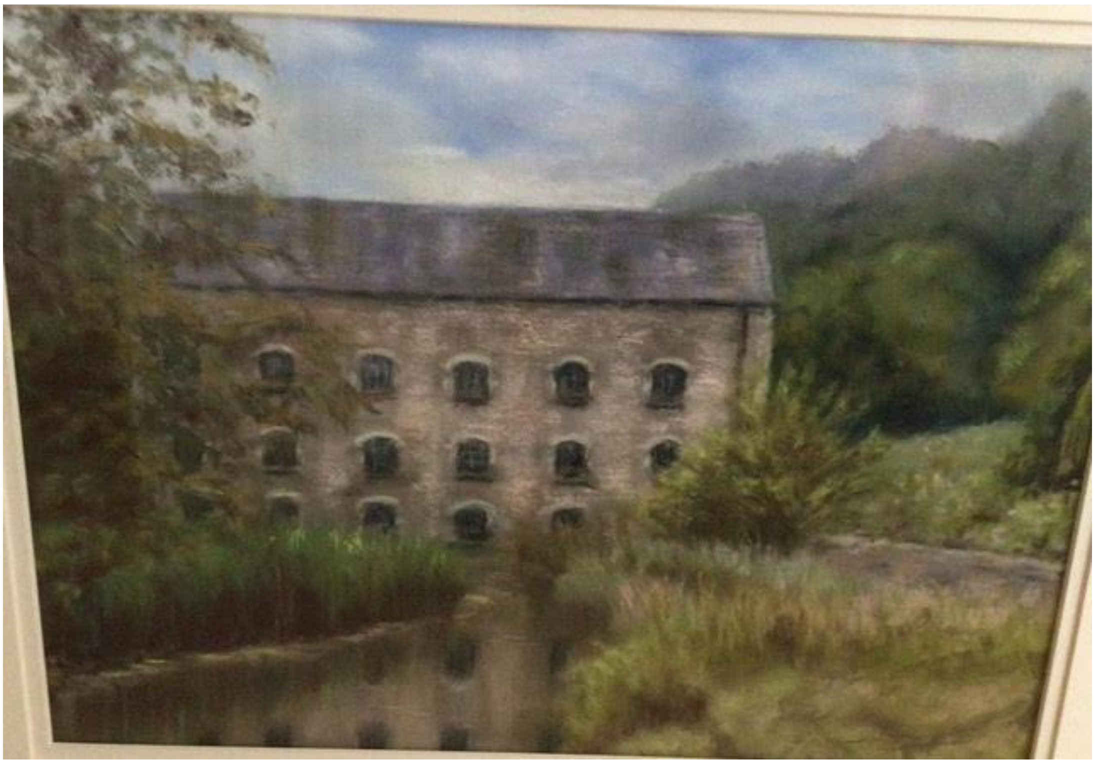
Written by and for the members of Box Art Group (No. 79)

Contents

The Commission

I was recently asked to paint my first commission! A friend, John asked for a painting of a Stroud mill. I was a bit apprehensive as he had only seen photos of my paintings, not the actual painting. I set about taking some photos of mills along the valleys as well as digging out ones previously taken. This wasn't as easy as I thought as some mills are inaccessible. My favourite photo was of Ebley Mill with the canal in the foreground, but John decided on Belvedere Mill in Chalford. I found that this was quite a challenge as the view of the mill was straight on with lots of windows to paint, not easy in pastel. After several weeks, the painting was finished and John and his wife were invited for tea and cake for the viewing. I hope he is pleased with it once it was hung in his house. The photo of the finished painting is attached.

I forgot to photo it prior to framing so the quality of photo is not very good as it had to be taken to minimise reflections on the glass. I tried rotating and cropping but too much of the image was lost. It was taken prior to Michael's talk so not up to his standard! *Jill*



Abstracts

These are two renditions of the same view of a field in Pinfarthings. The first one is more graphic with black outlines which makes it look a bit like a book illustration. The second is more realistic although still stylised. However, I think both paintings 'fail' because what I was actually trying to do was to make an abstract piece. But telling my realistic-orientated brain to do that is a challenge I've yet to overcome!

Richard B

Place: Home

Roxy has recently had an image included in the on-line publication, ‘HOME’. This book is published by the research collective, 'Space, Place, Practice', of which she is a member.

This book, place: home, has been two years in the making. The words and ideas contained here have developed through a particular set of circumstances in the pandemic of Covid 19, that punctured our sense of being, our notion of time and all that was familiar becoming more strange—each idea, intuition, admission or remonstration reinforcing or dismantling the other. These were drawn-out and protracted through life events, a reflection on the time itself perhaps, and now as we emerge tentatively and hopefully, the collation also emerges into something more familiar but without letting go of the strange and slightly weird time that has saturated us. Weird here being used in the sense that Mark Fisher determined, ‘that which does not belong’, which he used to point towards familiarity but something that lies beyond, and which is not reconcilable. To follow on with this thought, he developed this further by considering the equation of weird as being two or more things joined which do not belong together. When thinking back to that time, the desolate streets in once busy cities, images that we saw on television that scarred the senses of the well and not-so-well people being medicalised and being lost or recovering, the dichotomies that we were dealing with provoked an overwhelming a sense of wrongness that permeated our lives, it has probably brought us to a space where we are now more conscious of time and being in the presence of the new and what that might be.

You can see the whole book at http://spaceplacepractice.com/resources.html *Roxy*

Portrait

Having been 'volunteered' to sit for the portrait painters, I decided to try my own hand at a portrait, having purchased a set of fine drawing pens and another of pencils. I am not used to drawing and usually sketch a very faint outline and start painting almost immediately, however this time I tried with pens and pencils. I eventually produced two attempts, neither of which looked the least like my subject, but was cheered by Roxy's kind comment that it did look like a portrait even if not the right person!

I will not waste space by attaching the 'portrait' but here is a first attempt at sketching with fine pens.

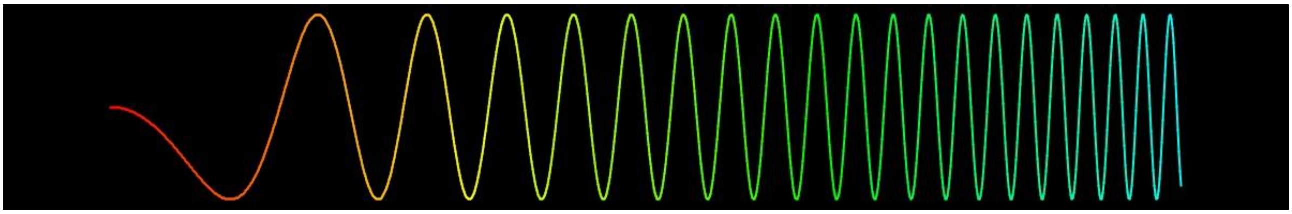
Hilary K

Colour Theory 1

I have recently heard some of our members asking about Colour Theory, and having started watercolour painting recently, I thought it was about time I did some of my own reading and thinking about the problem. As a professional physicist the behaviour of light was part of my stock in trade, but the behaviour of light in pigments turns out to be more complicated than I realised and I also found that understanding colour in art is as much about psychology as it is about physics. My researches have focussed more on watercolour rather than oils or acrylics, and though some of the theory carries across there are also distinct differences that are important when you are dealing with relatively thick and opaque pigment layers. Work for the future.

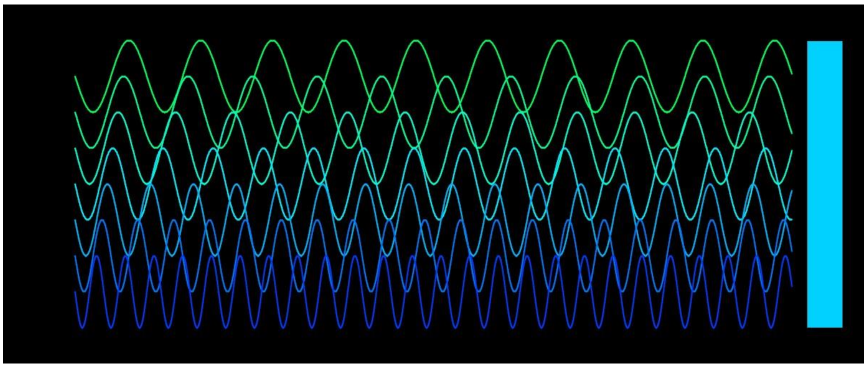
Along the way I soon learned that most of the books that I owned were pretty hopeless - sometimes positively misleading - and there is also a lot of slightly dodgy colour theory on the Internet. I had to wade through a number of websites that were clearly copying the same not very authoritative sources - adding their own errors - even though it soon becomes obvious to anyone who tries a bit of paint mixing that much of the guidance is not very helpful. So, my first job was trying to get to the people who really knew what they were talking about.

I do not know if my researches are going to help me - or you - with practical colour mixing: the most authoritative sources spend a great deal of time explaining just why naive colour models just do not work very well. It confirmed my opinion that what I really need is a lot of systematic experience mixing colours from a limited pallet.



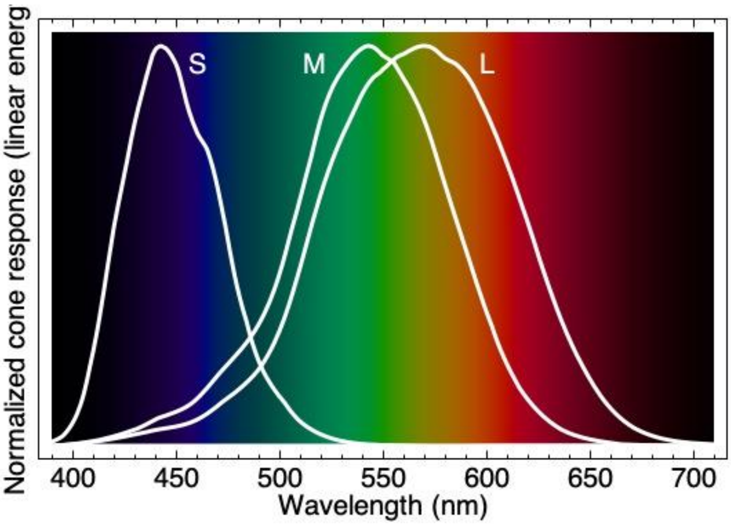
Different wavelengths are perceived as different colours

Let us first get the physics out of the way: a little understanding is helpful but not crucial. Light is a wave phenomenon - a vibration of the electromagnetic field. (Know-it-alls can forget wave-particle duality for this purpose - unless you really want to know why paint colours fade in sunlight!) The waves are very small: the distance between one wave crest and another is between 380 and 700 nanometers (1 nanometer is 1 billionth of a meter) for the waves detectable to the human eye - that is tens of thousands of wave peaks in each centimetre. Physicists can demonstrate the wave nature of light in their labs, but unless you know what to look for it does not make itself apparent in daily life. Short wavelengths look blue and longer wavelengths look red and the spread of wavelengths - the spectrum - is continuous: the perception of a rainbow dividing neatly into distinct colours is a matter of psychology not physics. We do informally talk about the colour of light, but strictly speaking light only has a wavelength and colour is made in the brain, but it is hard to do without the informal terminology and we just have to remember the right context.



Most of what we see consists of mixtures of wavelengths

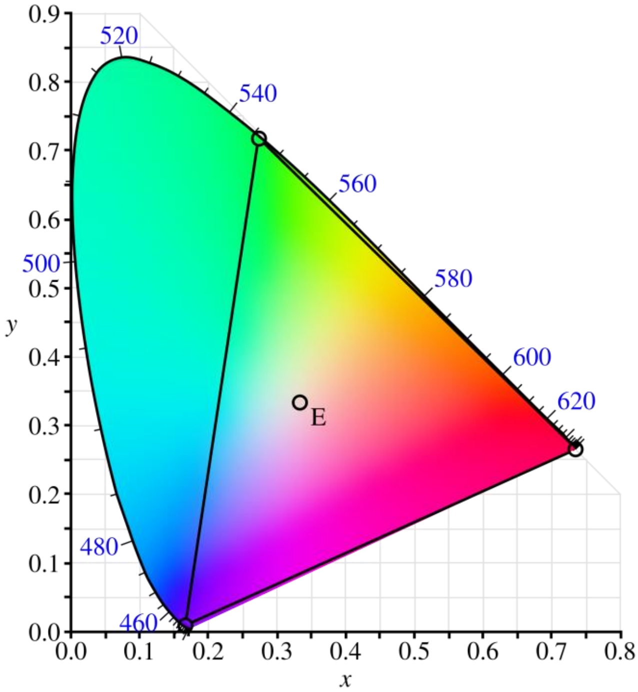
We see pure “spectral” colours in nature (that is light of a single wavelength) in rainbows, in some iridescent butterfly wings and in some minerals (gem-stones such as opal or labradorite) that make light dance according to the physics of *interference*. There is no point in my trying to include photographs of pure spectral colours: neither computer monitors nor the pages produced by inkjet printers come close to reproducing the effect they have on the eye. We also see pure colours in the light of lasers, but mostly when we look around at the world, the light entering our eye contains a spread of wavelengths and the colour that we perceive depends on how our eyes react and how the brain then processes the signals from the eye when stimulated by a range of wavelengths. The physics of waves is easy compared to the complexities of colour perception!. Informally, we talk about the colours of different wavelengths. Remember, however, that *wavelength* is an easily measurable physical property of light while *colour* is a phenomenon generated in the brain and is an experience that can only be reported. (My mathematician daughter - who is also a very good artist - sees numbers in colour! Synethesia like this turns out to be not all that uncommon.)



The sensitivity of “cones” to light of short, medium and long wavelengths
(source: Wikimedia Commons)

Our eyes detect light using different types of light-sensitive receptors, divided into *rods* and *cones*. Rods let us see in low levels of light but then we see only in monochrome. In daylight the cones take over and we perceive colour, because there are three types of cone, each sensitive to a different wavelength range, roughly described - not very accurately - as red, green and blue. More conventionally among vision scientists they are labelled as the L, M and S cones (where M, L and S refer to long, medium and short wavelengths). It is a rough description, because the sensitivity ranges overlap to a considerable extent, particularly the red and green cones, so a pure spectral "orange" would actually be stimulating both the red and green cones to a similar extent. I always find it remarkable that we perceive a bright green and a bright red as so different, when the nerve signals going into the brain from the red and green cones must be very similar.

Psychological experiments suggest that it is the fine differences between the stimulation of different types of cones that have a big influence on how colour is perceived. Such experiments have established the full range of distinct colours perceivable to the human eye. Dye and pigment manufacturers now refer to a standard method of distinguishing colours maintained by the International *Commission Internationale de l'éclairage* (usually known by the initials CIE). All the colours that the eye can distinguish can be plotted on a colour *gamut* map. (There are good technical reasons why this way of plotting is a better tool for scientists than the more familiar artist's colour wheel. You should Google "colour gamut" or "CIE colour space" if you really want to know the ghastly details, but prepare for *equations!)* This is good for engineers designing computer monitors or developing printer inks, but it will not help us artists very much, and in any case you would need the right professional software fed with all the right spectrophotometric data. It is, nevertheless, good to be aware that the fundamental issues have been investigated in considerable depth. Even these people, however, admit that it is difficult to predict from fundamental theory the effect of two or more artists' pigments mixing together.



The CIE colour space ("gamut") of the human eye with the RGB colour space triangle superimposed (source Wikimedia Commons - public domain.)

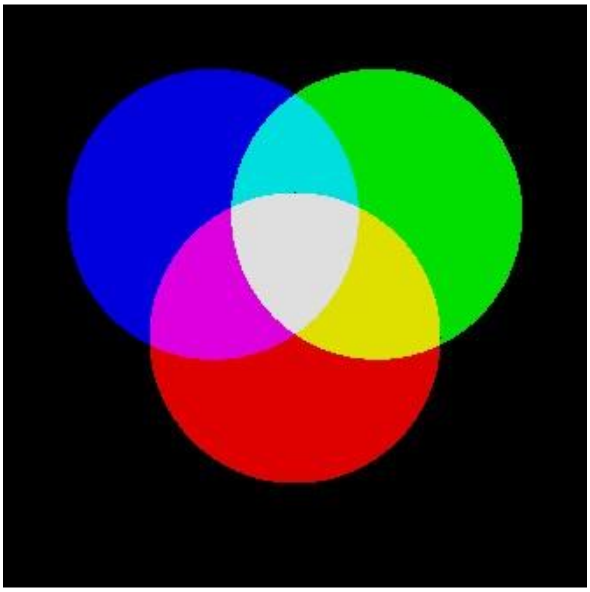
The numbers around the outside of the curve are the pure spectral wavelengths, while the inscribed triangle shows the *colour space* of red/green/blue computer monitors - that is the range of colours a monitor can reproduce. Anything outside this triangle is not representable on a computer monitor with the typical colours of RGB pixels, which you will notice covers quite a lot of colours, in the blue-greens. (So, what you are seeing *now* on *this* representation of the diagram - presumably on your computer monitor - is also misleading outside the RGB triangle.)

It is, of course, quite possible for particular inks and pigments to lie outside this triangle and so produce colour not representable on a computer screen. In practice, chemical and physical theory tells us that it is difficult to make solid compounds that reflect light in the narrow spectral ranges which would put them there (for that you need the physics of iridescence). It is in the fundamental nature of most solids that they absorb or reflect light over fairly wide ranges of wavelength.

Hence, there just is not that much stuff in the world that produces colour outside the RGB colour space, because the chemistry and physics is against it, and this is why our photographic systems (and sometimes paintings) do a reasonably good job of reproducing natural appearances. When pure spectral colours turns up in nature, as with butterfly wings, they grab attention - which is no doubt why these creatures evolved that capability.

There is clearly quite a lot of sophisticated processing going on in the eye and the brain because we continue to see objects as having the same colour even when the ambient light falling on and reflecting from their surfaces changes quite considerably, so a “red” apple still looks red to us under a very yellow artificial light. Back in the days of film photography, if you took a photograph indoors under artificial light it would come back from the processors looking very yellow, with most of the colours appearing distorted. Although the light entering the eye must be the product of the colour of light hitting a surface and the way it is modified by the surface, what we perceive seems to be automatically adjusted to maintain typical visual appearances - as I noted above we are sensitive to differences in colours and do not register absolute colours. These days, digital cameras attempt to reproduce some of the brain’s processing, usually pretty well, and we almost get a “natural” colour balance with indoor photographs - but the software required to do this teaches us that there must be quite a lot going on in the eye/brain.

Naively, you might think that all we have to do with an artificial image is to reproduce the stimulations of the red/green/blue cones in order to reproduce the sensation of looking at the real thing. Hence, elementary colour theory suggest that there are three *additive* primary colours, red, green and blue, and we can mix these colours to get anything the eye can see. It is not entirely wrong: all TV screen and computer monitors consist (if you look very closely) of patterns of red, green, blue dots which are switched up to different intensities in order to create an image. I created the figure on the right with a simple computer program that told my computer monitor to switch on red, green, blue pixels in each to the three circles, with areas that overlap having two colours switched on - or all three in the centre. It clearly works! (In fact there are a number of technologies around, some of which give brighter more saturated colours than others.)



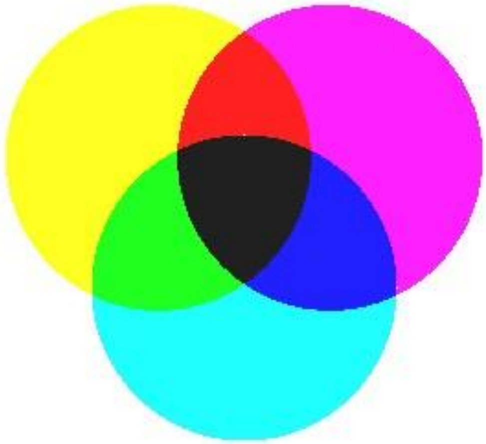
Additive Primary Colours

It does not, in fact, work as well as you might at first think, and we can thank the brain’s sophisticated processing for helping to fool us. The engineers who design monitors also know a good deal about the psychology of human vision and are skilled in persuading the eye to perceive colours as somewhat brighter than they really are in absolute terms. The red/green/blue light sources in a TV screen each produce a spread of wavelengths not pure spectral colours, so there is no way to reproduce the exact sensation the eye gets from seeing pure spectral colours. A pure spectral deep red (or blue for that matter) would give a lot of stimulation to the red (blue) cones and little to the other cones. A colour spread around red (or blue) will inevitably always stimulate some of the other cones. Furthermore, these primaries are not the colours that give the maximum stimulation to each type of cone: it turns out that it is better to spread the green and red slightly further apart. Colour professionals say that the “gamut” of a TV screen (the “RGB” colour space) is more restricted than the natural gamut of the eye. (See the colour space diagram above.)

We do not normally notice the restriction because practically everything we see around us in the world is reflected colour, and this tends to have an even more restricted colour gamut than the typical TV so it does not test its limits. On the other hand, if a natural history photographer wants to image the wings of one of the butterflies that produce so-called “interference” colours (that is, they use microscopic physical structures, rather than pigments, in order to filter light down to much purer spectral colours) then they are likely to be a little disappointed with the results. It just does not “knock the eye out” in quite the same way as the real thing. Your photos of rainbows are never quite as good as the real thing. We can now manufacture surfaces that use similar physical effects to create *iridescent* colours (and you can even get iridescent paints) that would plot outside the RGB colour space in the gamut diagram above. The great majority of pigments (or indeed most natural surfaces) do not plot outside the RGB colour space.

Much of the colour we see around us is produced though a modification of incident light (natural or artificial) reflected from surfaces. The surface absorbs some colours and reflects others. The natural light we see outdoors is perceived as “white” by our eye for example when reflected from a sheet of paper, with no particular colour bias. If, however, we reflect it of a surface that absorbs red and green light it will appear blue. Similarly, a surface that absorbs blue and green light looks red and a surface absorbing blue and red light will look green. One obvious point is that a painted paper will certainly be reflecting less light in total compared to an unpainted sheet because some light is absorbed. The more absorbing pigment that you add to the paper the less total light that it will reflect. (A yellow paint, for example, may, however, still *appear* bright because of psychological effects.)

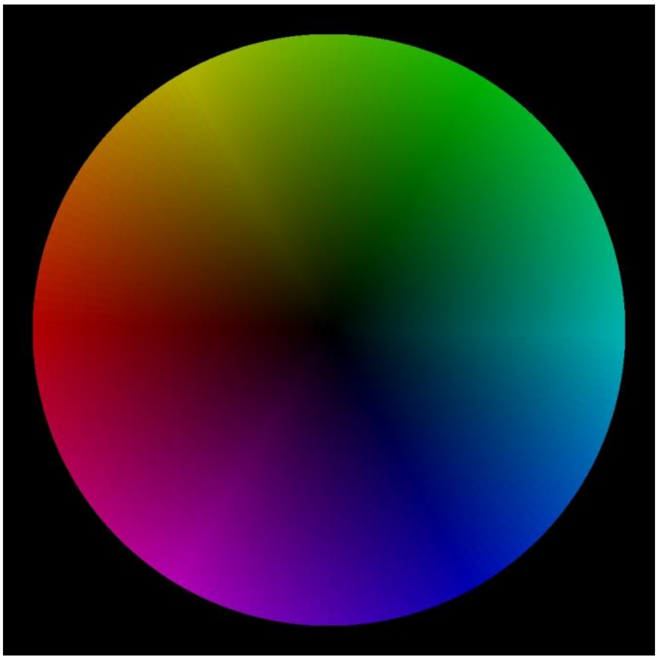
From this we can get the theory of *subtractive* primary colours. If we produce a filter plate that stops just red light, from the other side it will look blue-green (usually known as cyan). Similarly, a filter that stops green light, but lets through red and blue will look from the other side to have a magenta colour, and the filter that stops blue but lets through green and red will let through light that looks yellow. Hence if we put our cyan filter (stops red) in front of our magenta filter (stops green) we will only see blue on the other side. The combination of cyan and yellow produces green, and the combination of yellow and magenta produces red. All three filters should stop everything thereby producing black. This is the way colour film photography used to work: the emulsion had cyan, magenta and yellow filters in three separate gelatine layers in which dye molecules absorbed red, green and blue light. The use of dye rather than pigment (i.e. coloured particles) meant that less light was scattered passing through the filter layers and photographs could produce both good contrast and good colour rendition.



Subtractive Primary Colours

It is also the way most process printing works - by subtracting colours from the incident light. While in theory you just need three types of ink to filter light as it reflects off white paper, in practice laying cyan, yellow and magenta on top of each other does not produce a very good black and you need quite a lot of the expensive coloured inks to even get that far, so black ink is also used in the so-called four-colour printing process. In reality, the colour range it can represent (generally known as the CYMK gamut) is even more restricted than that the RGB gamut. That is partly due to the less than perfect light filtering of the inks but also because some light always gets reflected from the surface of the print, reducing potential colour saturation, and some light is always absorbed by the paper, reducing the potential brightness of the colour. Your home-computer so-called photographic quality ink-jet printer tries to do a little better by using a wider range of inks (mine uses six - it adds a “light cyan” and a “light magenta"). CYMK is however generally good enough for things like textbooks and most commercial printing, though it would struggle with the reproduction of the highest quality company prestige publicity material. (That is why you may need to use six-colour or even the sixteen colour Pantone system for more challenging material, such as art reproductions.) Ink can be made of our dyes or pigments usually supported in a rapidly drying medium. Dyes are soluble in the medium while pigments are solid particles - usually very finely ground in inks. During drying, dyes may chemically attach to the substrate, whereas pigments lie on the surface (though small particles may well work their way into paper fibres). Subtractive colour printing clearly works pretty well - though it is not perfect.

We should note here, however, that the term “subtractive” is itself misleading: we are really dealing with a *multiplication* effect. For example, a cyan filter may well be letting through half of a certain wavelength of light - say that which we would perceive as orange. Similarly a magenta filter may also let through half of the same colour. Putting the two filters together *does not* subtract two halves to give one, it *allows through* 1/2x1/2 = 1/4 that, a quarter of the orange light still gets through. A perfect subtractive filter switches from letting all the light through for one wavelength band, and letting nothing through for all other wavelengths. No real dyes and inks are as good as that: they always absorb some light at any wavelength and also reflect some, so there are colour bands where additive and subtractive effect both have some influence. The more I read the more complicated it seems to get!



The colour wheel turns out NOT to be a good tool for guiding the mixing of pigments.

It gets more complicated still when we remember that the paints we use are made with *pigments*, that is, coloured particles embedded in a binder (e.g. oil, acrylic or gum arabic). Pigment particles can be even more free and easy than the dyes in the way they absorb some wavelengths and reflect others. Two blue pigments that have a similar colour appearance to the human eye may well be reflecting and absorbing light in different ways: one might reflect a fairly narrow band of wavelengths while the other turns back a much broader range. These two blues may therefore behave in quite different ways when mixed with other colours which have their own complex pattern of absorbing and reflecting light.

Even with the CIE colour plot, reliable mixing results are not easy to predict accurately with any of the simple colour models. It is even harder with the standard artists' colour wheel using either of the additive or subtractive naive colour models. Firstly, most real pigments do not plot near the outside of the colour wheel: only a few, such as the cadmium yellows, achieve even 80% saturation and most greens and blues tend to be closer to 50-60%. (See this link https://www.handprint.com/HP/WCL/cwheel06.pdf for a definitive diagram.)

The fundamental message here is that a scientist who wishes to predict how pigment mixtures behave need to measure the amount of light reflected from each pigment at each separate wavelength in the visible range, and the overlay the two graphs to see which colours get reflected and absorbed in the mixture. You cannot make general rules about, say, mixing blues and yellows: only about, say, mixing cobalt blue and chrome yellow. You and I do not have this information and will have to rely on practical experience, by getting to know the mixing behaviour of a limited range of pigments on a manageable palette. But remember, it is the *specific pigments* that matter. (I shall research this further for a future note.)

If you want to dig deep, the "Handprint" website https://www.handprint.com/HP/WCL/water.html contains a mass of detailed technical information about watercolour brushes, papers and paints - more than you will probably ever want to know - unless like me you are a science nerd and just want to know how things really work. The author seems to have researched his material carefully and has not taken anything for granted. (He, and others, have performed their own experiments to show that you cannot always rely on manufacturer's information. For example, some of the data they reproduce about lightfastness has been traced to other sources now known to be unreliable!) You will need to look elsewhere for information about oils and acrylics.

I also like Jane Blundell's website (see for example https://www.janeblundellart.com/getting-started-in-watercolour.html) which takes an experimental approach to practical colour mixing and includes lots of mixing swatches. She also gives examples of how the appearance of the same pigment may vary considerably with different paint suppliers (see for example, https://www.janeblundellart.com/earth-watercolour-swatches.html).

The Jackson Art website (https://www.jacksonart.com) also has, if you dig around, a number of useful articles about art materials that seem to be well-sourced, not excessively overloaded with marketing hype, and this does look at oils and acrylics.

That is enough for now. I will talk more about real pigments and how they behave in mixing in a future note.

Michael

Exhibitions and Events

The Stroud Artists Cooperative is holding a Christmas Market in St Lawrence Church on Saturday 17th December from 09:30 to 15:00.

There's also an exhibition in the Lansdown Gallery:

Autumn Term Sessions

1st December Beth Post photograph processing with Michael McEllin
Portrait Sitters: 1st December: Margaret Adams and Mike Cooper

8th December Final Session this year with Beth

- Bring and buy table of donated materials
- Bring your own mince pies & Christmas social
- Make a wooden Christmas tree decoration

Please see photo below and description of the kind of decorations people could make.

Drop-in workshop where you can make your own personalised decoration, either using paint and pre made stamps, or natural materials and sealing wax. Or make tiny paintings on the wood bases.

No need to book, the activity will run throughout the session and people will be able to dip in and out. All materials will be provided, but if you have some nice twigs and berries, or your own stamps, please bring them along. If you want to paint your decoration, bring your own brushes, I will provide a small selection of acrylic paints. (but bring your own if you prefer)

The cost is £1 for every decoration you make and you can make as many as you like.

Beth
Any questions please don't hesitate to ask!

12th January 2023 Spring term begins