BY **MIKE WOOD**

Feeling blue

JUST TO PUT YOUR MIND AT REST, no, I'm not going to write about COVID-19 and its effects on the industry, you already know that far too well. No, I'm going to write about the color blue and the word blue. Well, actually I'm going to ramble on all over the place. (The *Protocol* editor lets me write about anything I want to, so you get this whether you like it or not.)

> **"What we perceive as a clear and obvious distinction between blue and black isn't real. It's a figment of our imaginations."**

I do have to admit, however, that what first made me think about "blue" was COVID-19. We were watching the VE Day 75th memorial concert from the Royal Albert Hall in London. (How did we survive before YouTube?) It was a strange concert as the only people in that famous concert hall were the singer, Katherine Jenkins, and her pianist. They were facing upstage, so the backdrop was the 5,000 empty seats in the hall. Anyway, I digress. Katherine Jenkins (fabulous mezzo-soprano) was singing the old wartime favorite song, "The White Cliffs of Dover" which had been a hugely successful wartime hit for Vera Lynn. For some reason, although I'd heard this song thousands of times before I noticed the lyric had a problem. The song starts with the line, "There'll be bluebirds over the White Cliffs of Dover." Nothing wrong with that until you realize that there are no bluebirds in England; it's an American bird not known in Europe. How had I gone my whole life not noticing that before? I guess it just becomes so familiar that you don't think about what the lyric is saying. When I checked on Wikipedia, the fount of all knowledge, I was surprised to learn that the song was written by two Americans in 1941 and recorded by Glenn Miller. It wasn't until 1942 that Vera Lynn recorded her version. I guess the lyricist, Nat Burton, had no idea that we didn't have bluebirds in the UK.

As an aside, I warned you I was going to ramble. That's a minor transgression but the really annoying misunderstanding of the bird life of England is in the 1964 movie, *Mary Poppins*. The song, "A Spoonful of Sugar" is accompanied by a robin whistling harmony to Mary. However, the bird that the film makers modeled was an American robin, not a European robin. Completely different birds, different sizes, different species, different behavior. To English eyes, the bird in the movie looks like some kind of strange red thrush. Julie Andrews must have known it was wrong for Cherry Tree Lane in the middle of London, but was perhaps too polite to say? That, and Dick Van Dyke's English accent, probably did more to damage US/UK relations in 1964 than LBJ and Alec Douglas-Home and their spat over Cuba!

Figure 1 - American and European Robins

Figure 2 - ???

Anyway, let's get back to bluebirds, or blue birds. No, bluebirds as a species don't exist in the UK, but they do have birds with blue feathers. The most spectacular of which is probably the Kingfisher.

Figure 3 - Common Kingfisher

What all blue birds have in common, no matter where they originate, or which species they are, is the mechanism that causes those blue feathers. Unlike most other colors, it has nothing to do with pigments. There are some blue dyes in nature, often more purple than blue, but they are all plant-based; animals and feathers don't contain any of them. Even plants that appear blue are very often, in fact, using a red pigment known as anthocyanin. Through pH shifts and a mixing of pigments, combined with the reflection of natural light, the plants generate the appearance of a naturally occurring, blue color. With animals just about every instance of blue is a structural color, as opposed to a pigmented color, and is caused by the microstructure of the fur, scales, cells, or feathers forming an optical structure that reflects blue light. The few exceptions include one or two butterflies and Brazilian blue poison dart frogs.

"That, and Dick Van Dyke's English accent, probably did more to damage US/UK relations in 1964 than LBJ and Alec Douglas-Home and their spat over Cuba!"

Richard Prum, an ornithologist at Yale, has investigated many different feathers from different blue birds that live in Central and South America and analyzed what makes them look blue. "Blue is fascinating because the vast majority of animals are incapable of making it with pigments," Prum says. "In fact, of all Earth's inhabitants with backbones, not one is known to harbor blue pigment. Even some of the most brilliantly blue things in nature — a peacock feather, or a blue eye, for example — don't contain a single speck of blue pigment." Prum and his research group discovered that as a blue feather grows, a specific internal structure develops. A feather is composed, like our hair and nails, of dead cells with the strength coming from the fibrous protein keratin. As feathers are produced as living cells the keratin and water separate into droplets, a bit like oil and water. Then, after the feather emerges, the water evaporates and is replaced by air, leaving a structure with regions of keratin protein in a three-dimensional sponge-like structure interspersed with air pockets. This structure makes the feather incredibly strong and lightweight, like a truss or space-frame structure, but is also responsible for the color. The lattice of keratin and air is small enough that it scatters light differently for different wavelengths, causing destructive interference for the longer wavelengths of red and green light while causing constructive interference and reflection of the short wavelength blue. This is a process similar to the Rayleigh scattering that happens in the earth's atmosphere and makes the sky look blue. Different birds have slightly different shapes and sizes of the keratin and air pockets and thus slightly different shades of blue. This scattering differs from the process that creates the shimmering iridescent colors on, for example, the throats of hummingbirds or many butterfly wings. They are again a structural color produced by keratin or chitin structure, but in this case it's parallel, flat, layers of keratin, not a spongy layer of air bubbles and keratin. You can tell the difference easily enough. If the color changes with viewing angle and movement, then it's a flat layered structure. If instead, the color remains constant at all viewing angles, as most blue feathers do, then it's Rayleigh scattering from a 3D bubble structure.

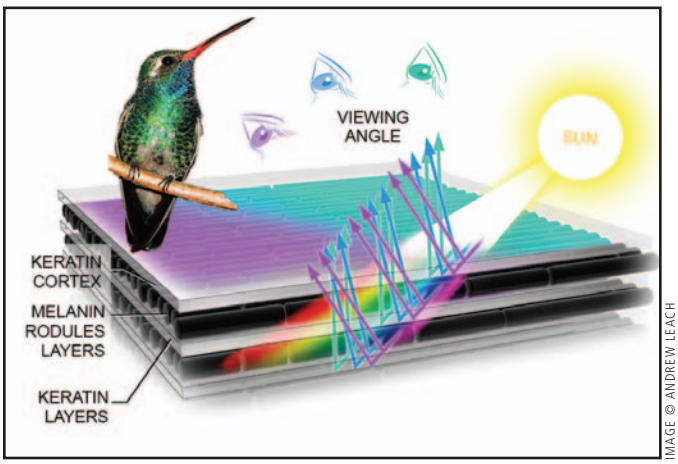

IMAGE © ANDREW LEACH

Figure 4 – Iridescent Structure

It isn't just birds that have evolved this trick. Blue butterflies are blue because of the layers of chitin in their scales. The same with some snakes and frogs. Colors in animals typically evolved for either camouflage or communication purposes. Green is a great color for an animal to hide in leaves, but it seems that assimilating or making

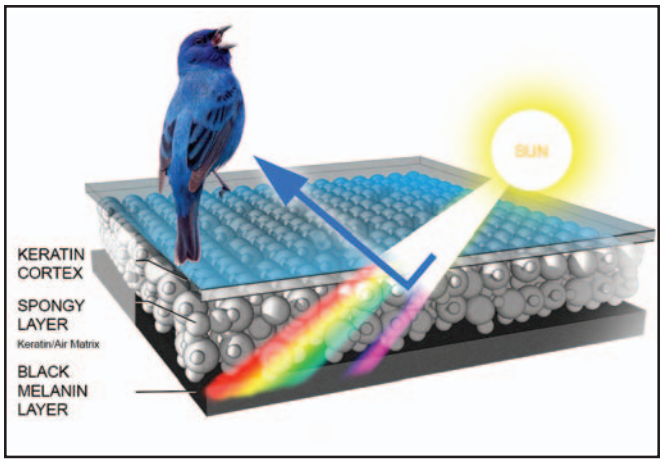

IMAGE © ANDREW LEACH

Figure 5 – Rayleigh Structure

green pigments is almost as difficult for animals as making blue, so some green frogs and snakes aren't actually green at all. They have a yellow pigment in their skin and a blue structural color formed by the light scattering in their scales. The net result appears green.

The color blue is a relatively recent addition to human perception. Of course, it's always existed, and we've always been able to see it. Human time scales are too short for any meaningful evolution of the structure of our eyes. However, that doesn't mean to say we've always noticed it. As we've just discussed, it's a relatively rare color in nature, particularly if you are a nomad living in forests and savannahs. As we've discussed in an earlier column in this series, the ancient Greeks didn't have a specific word for blue and instead described it as a shade of grey, or as having an iron hue. In fact, in all cultures, a word for blue comes very late in language development. In 1898, the psychiatrist W.H.R. Rivers visited the Torres Straits Islands, between New Guinea and Australia. He found that the elders described the sky as black, and a child describing the color of the sky would say it was dark as dirty water. He and other anthropologists concluded that early humans and isolated cultures were not color blind. They see all the colors that we see but consider them as simply hues of white or black or red, not worth inventing a special word for.

Having a name is important. When a color becomes important enough to us that it justifies having a special name, we start to emphasize it. Our brain and our language train us to see it as different, more so than before. We perhaps shouldn't be surprised that those islanders described blue as "dark" or close to black, we know our eyes are relatively insensitive to blue light, so as raw data it would truly appear as a dark color. However, as time goes by, society, usage, and language train us to notice it so that it appears (not "is" but "appears") brighter, until we get to today where we see blue as one of the brightest happiest colors. A few hundred years is all it took, so all the evolution is mental not physical. We've exaggerated what little difference there actually is. What we perceive as a clear and obvious distinction between blue and black isn't real. It's a figment of our imaginations.

Why are we using blue lights to celebrate health workers in the "Light it Blue" campaign? Why does the word "blue" in English mean unhappy or sad? Why does the word "blue" in German mean to be drunk? Why does the word "blue" in Russian mean to be homosexual? What exactly are the blues? Why is it "blue for a boy"? Why is the aristocracy blue blooded? Why are the laws concerning the sale of alcohol called blue laws? Why does blue also mean obscene or vulgar? Is a blue movie unhappy, obscene, or a film of the Blue Man Group? Perhaps all three! Sacré Bleu! ■

Mike Wood runs Mike Wood Consulting LLC, which provides consulting support to companies within the entertainment industry on product design, technology strategy, R&D, standards, and Intellectual Property. A 40-year veteran of the entertainment technology industry, Mike is a past President of ESTA and Co-Chair of the Technical Standards Council. Mike can be reached at mike@mikewoodconsulting.com .

Postscript:

Just as this article was going to press we got the sad news that Vera Lynn had died at the age of 103. The Queen had acknowledged her in a speech about the pandemic only a few weeks ago by echoing her words, "We'll meet again." Even without Vera Lynn present this will still be true, the present situation will pass and we *will* meet again.