

CYBORG  
FOUNDATION

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'Not many people go for a walk in the supermarket for fun, but I do. I have an electronic eye that converts light into sound to enable me to "hear" colour – so the cleaning product aisle is very exciting. The rows of rainbow-coloured bottles sound like a symphony to me.'

-Neil Harbisson

# NEIL HARBISSEON – A CYBORG ARTIST

## 1. 'I SEE IN BLACK AND WHITE'

Neil explains how he first realized he couldn't see colour, how he was diagnosed with achromatopsia and how he had to adjust to this reality while growing up.

## 2. THE EYEBORG

As told by Adam Montandon, the Developer of the first eyeborg. He explains how he worked together with Neil on the project: how the eyeborg was conceived and how it became a reality. You can also find information about how it works and how it relates sound frequencies to colours.

## 3. SONOCHROMATISM

Introduction to this term which Neil uses to describe his new condition. Here you can also find the two sonochromatic scales that Neil has both used in the past and at the moment.

## 4. 'I BECAME A CYBORG'

This is the moment he realizes the brain and the software have united and he is no longer a stranger to colour.

## 5. CYBORGISM

Neil starts to discover this new sense and the experiences that causes. Colour and sound merge into a new world of possibilities that he continues to explore through his art.

## 6. CYBORG FOUNDATION

Here you can find information about the Foundation, a nonprofit organization that aims to help people become cyborgs (extend their senses by applying cybernetics to the organism); defend cyborg rights and promote the use of cybernetics in the arts.

## 7. ANNEX

We include an extended version of Neil's talk 'Hearing Colour' that he gave at Ted 2012.

## ‘I SEE IN BLACK & WHITE’

I was born with achromatopsia, a condition that means I see the world in greyscale. I was diagnosed when I was 11; before then, my parents thought I was just confusing colours, or couldn't learn the difference. At first, doctors told me I was colour-blind; then, they thought it was a very severe case of colour-blindness and finally, they realized that I could only see in black and white.

As a child, I tried lots of ways to understand colours. I related them to people: when someone talked about blue, I thought about a friend of mine who was very brainy. Pink was a feminine, hippie kind of girl; yellow was a boy from London, very childlike and eccentric.

Kids at school teased me – once, someone gave me a red pen and told me it was blue, and I wrote a whole essay in the wrong colour. People found it funny when I wore mismatched socks, and as a teenager I wore only black and white clothes. In secondary school, my art teacher gave me permission to paint in greyscale.

When I moved to Devon to study music composition at Dartington College of Arts, I heard a lecture by Adam Montandon, a cybernetics expert. He helped to create my first “eyeborg”, which lets me hear light waves. The very first thing I looked at with it, outside the classroom, was a red noticeboard. It made the note F, the lowest sound on the spectrum. Red was my favourite colour for years. Now it's aubergine because it sounds unusually high pitched.

Neil Harbisson,  
Barcelona 2013

## THE EYEBORG

By Adam Montandon, developer of the first eyeborg

I first met Neil at Dartington College of Arts whilst I was giving a talk on practical cyborg techniques and applications. Neil became very excited about the idea of using digital inputs to augment his senses. He explained to me that he had a rare condition of achromatopsia (a hereditary vision disorder which affects 1 person in 33,000), the inability to perceive colour.

To him the world was black and white. He explained to me how, in his paintings he had only ever used black and white paints: “I never used colours to paint because I feel completely distant to them. Colours create a mysterious reaction to people that I still don’t quite understand.”

He described colours to me as “being an energy that I can’t see because it moves too quickly. I’ve imagined colours as fast moving energies.” Neil became curious as to the possibilities of a cyborg-like extension of his sensory system. A new input based prosthesis.

I decided that using Neil’s existing senses as a host for new artificial senses would be an effective approach. By using sound, I felt that it would give him a good approximation of colour as he has very good pitch perception as he is a keen musician.

I was confident that shifting colour into sound would be an appropriate and effective way of re-mapping Neil’s brain, as the natural occurrence of synesthesia seems to suggest that the visual and auditory senses can in some case become overlapping.

The case of how to convert colours into sounds was a difficult one. After much consideration it became apparent that I would have to create an audio experience that, like the light spectrum, would transcend labels. I used a physical model of transposing light into sound. After all, both light and sound are waves.

Although light waves are far too high to hear, it is possible to mathematically transpose them down until they sit within the audible wavelength, so the lowest colour in the spectrum (Dark red) becomes the lowest note in the scale. I created colour to sound conversion software that would dynamically scale the colours from a miniature wearable camera into audible frequencies.

Instead of having one note per colour I wanted Neil to be able to hear subtle differences in colour, just as the human eye can distinguish between many different kinds of blue, Neil is able to do the same.

Neil can now perceive 360 different hues, one for each degree on the colour wheel. Each hue was assigned an audible frequency between 384 and 718. This approach allows him to disregard brighter and darker variations (due to lighting conditions) and also to disregard colour saturation (The camera may over or under saturate colours depending on the environment) and instead gives us pure Hue perception.








## SONOCHROMATISM





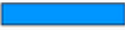







Harbisson uses the terms sonochromatism or sonochromatopsia (Latin: sono-, sound + Greek: chromat-, colour + Greek: -opsia, visual condition) to define his new condition. He explains that achromatopsia can no longer define his visual condition because achromatopsics cannot perceive nor distinguish colours.

He also explains that synesthesia does not define his condition accurately because the relation between colour and sound varies depending on each person, whereas sonochromatopsia is an extra sense that relates colour to sound objectively and equally to everyone.

- Harbisson's Sonochromatic Scales

**Harbisson's Sonochromatic Music Scale (2003)** is a microtonal and logarithmic scale with 360 notes in an octave. Each note corresponds to a specific degree of the color wheel. The scale was introduced to the first eyeborg developed by Adam Montandon in 2004.

PURE SONOCHROMATIC SCALE		
(invisible)	Ultraviolet	Over 717.591 Hz
	Violet	607.542 Hz
	Blue	573.891 Hz
	Cyan	551.154 Hz
	Green	478.394 Hz
	Yellow	462.023 Hz
	Orange	440.195 Hz
	Red	363.797 Hz
(invisible)	Infrared	Below 363.797 Hz

SONOCHROMATIC MUSIC SCALE (basic 12/360)		
	Rose	E
	Magenta	D#
	Violet	D
	Blue	C#
	Azure	C
	Cyan	B
	Spring	A#
	Green	A
	Chartreuse	G#
	Yellow	G
	Orange	F#
	Red	F

**Harbisson's Pure Sonochromatic Scale (2005)** is a non-logarithmic scale based on the transposition of light frequencies to sound frequencies. The scale discards colour as being part of a colour wheel and ignores musical/logarithmic perception so it can overstep the limits of human perception.

## 'I BECAME A CYBORG'

**'It's not the union between the eyeborg and my head what converts me into a cyborg but the union between the software and my brain, a union that has created a new sense in my brain that allows me to perceive colour as sound. I never take the eyeborg off: I wear it to sleep, and in the shower. It feels like a part of me. When I started to hear the sound of colour in my dreams, that's when I began to think of myself as a cyborg.'**

In 2004, Harbisson was not allowed to renew his UK passport because his passport photo was rejected. The passport office would not allow Harbisson to appear with electronic equipment on his head. Harbisson wrote back to them insisting that the eyeborg should be considered part of his body as he had become a cyborg. Letters from his doctor, friends and his college were sent to the passport office to give him support. After weeks of correspondence Harbisson's prosthetic device was included and he became the first official cyborg recognized by a government.

**How is the eyeborg? Where is it located?** In the beginning, I had cables coming out of my head, snaking down into a big backpack with a laptop. It made people a bit uncomfortable. But now the eyeborg translates colour into sound using a chip at the back of my skull. It makes noise by pressing against my head and I hear colour through bone conduction. This way, it doesn't interfere with regular hearing because it comes through different channels.

I still have to recharge myself at a power socket, but I'm working on ways to use my blood circulation instead. In the near future I'm having it osteointegrated - which means that part of the device will be put inside my bone in a hospital in Barcelona and then the sound will resonate much better. It took a year to convince them that it was ethical to have the eyeborg implanted.

**How does the eyeborg work?** Colour is basically hue, saturation, and light. Right now, I can see light in shades of grey, but I can't see its saturation or hue. The eyeborg detects the light's hue, and converts it into a sound frequency that I can hear as a note [wavelength is inversely proportional to frequency so it can easily convert the wavelength of the light into a sound frequency]. It also translates the saturation of the colour into volume. So if it's a vivid red I will hear it more loudly.

**How long did it take you to learn how to use it?** About five weeks but it was five weeks of 24/7. After five weeks my headaches went away and it became automatic. That was in 2004. Now it feels normal, it's just like an extra sense.

**Can you go beyond the normal range of the 360 or so visible hues?** I perceive near infrared - I perceive colour that is invisible to the human eye. And also near ultraviolet. The thing about perceiving UV is that it's good to detect it because it damages the skin and I can know about it beforehand. This allows me to perceive pictures that no one else sees.

## CYBORGISM

**‘Cyborgism is an artistic and social movement that aims to create artworks through new senses or the extension, reduction or modification of an existing sense as a result of the union of cybernetics and the body.’**

Thanks to the eyeborg, I’ve made a career by combining music and art. I do concerts where I plug myself into a set of speakers and play the colours of the audience back to them. The good thing is that if it sounds bad, it’s their fault!

I also do portraits live by pointing at the different hues on the different parts of the face, so I can create the chord of a face. Prince Charles sounds surprisingly similar to Nicole Kidman. This is how I found out that there are no black or white skins. We all are different shades of orange.

When I started to use the eyeborg I realized that cities were not grey, every city has a dominant colour or two so I started a project that consists in scanning the streets to find out city colours.

I began to perceive sound as colour, too. Telephone lines became green; Amy Winehouse’s Rehab song seemed red and pink. So I started to paint using the sounds around me. I’ve made pictures of pieces by Vivaldi, Beethoven and Mozart among others.

I also do the opposite, I create colour portraits from voices. I’ve created Martin Luther King and Hitler in colour from their speeches and I’ve showed the result to people and asked them to guess which one’s which. And people usually get them wrong. Hitler’s appears very colourful because he used a wide range of frequencies in his speeches whereas Martin Luther King’s speeches have dominant colours such as different shades of blue and purple.

The eyeborg has changed the canons of beauty for me. I like listening to paintings by Andy Warhol, Joan Miró and Mark Rothko, because they all produce very clear notes. But Da Vinci, Velázquez and Munch can sound disturbing. Their paintings contain many shades of the same colour, so they produce clashing chords due to having notes that are very close to each other. They sound like the music from a scene in a horror movie when something bad is about to happen.

For more information about Neil’s artwork, please contact us at [hello@neilharbisson.com](mailto:hello@neilharbisson.com)

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## CYBORG FOUNDATION

**'There's no legal protection for cyborgs. In 2010, I started a foundation to protect our rights. I've been kicked out of Harrods because I was perceived as a possible security threat, and many cinemas don't let me in because they think I'm going to record the film. I did get permission to appear with the eyeborg in my passport photograph, which has made things a lot easier with airport security.'**

The foundation was created as a response to the growing amount of letters and emails that Neil Harbisson received from people around the world interested in becoming a cyborg. Since its creation the foundation has kick-started several new-sense development projects and has collaborated with several institutions, universities and research centers around the world.

The Cyborg Foundation was first housed in Tecnocampus Mataro (Barcelona) and is currently based in the center of Barcelona. In 2010, the foundation was the overall winner of the Cre@tic Awards, organized by Tecnocampus Mataró. In 2011, vice-president of Ecuador Lenin Moreno announced that his government would collaborate with the Cyborg Foundation to create sensory extensions and electronic eyes.

Our mission is to help humans become cyborgs, to promote the use of cybernetics as part of the human body and to defend cyborg rights. We do not sell cybernetic extensions, we believe that cybernetic extensions should be treated as body parts, not as devices, and therefore should never be sold. Instead we encourage people to create their own sensory extensions.

We do not intend to repair people's senses, we make no difference between people with "disabilities" and people with no "disabilities", we believe we are all in need to extend our senses and perception. We are all disabled when we compare our senses with other animal species.

- Other projects

**SPEEDBORG:** Internal radar that allows you to perceive the exact speed of movements in front of you via vibrations. First prototypes were attached to the hand (2007-2009) followed by others attached to the earlobes.

**FINGERBORG:** The fingerborg project consists in extending the senses of a multimedia student who lost a finger in an accident. The first fingerborg prototype consisted of a prosthetic finger with a miniature camera inside that allowed him to film and take pictures with his own hand. The aim of the project is to upgrade the current fingerborg to one that allows him to receive direct feedback from the camera to his hand.

**360° SENSORY EXTENSION:** The project consists in extending human perception to 360° by adding sensors at the back of choreographer Moon Ribas' head that vibrate when someone approaches her from behind. The first prototype consisted of a pair of earrings with movement sensors at the back. The earrings allowed her to feel a vibration on her left ear if someone was standing somewhere behind her left, and a vibration on her right ear if someone was standing somewhere behind her right.

## TED TALK by Neil Harbisson – ‘Hearing Colour’

(IMAGE 1) I come from a place where the sky is always grey; where flowers are always grey; and where television is still in black and white. I actually come from a world where colour doesn't exist; I was born with achromatopsia, I was born completely colourblind. So I've never seen colour, and don't know what it looks like.

But since the age of 21, I can hear colour.

In 2003, after studying fine arts and while studying music at Dartington College of Arts in England, I began a project with computer scientist Adam Montandon with the aim of extending my senses. The result, with further collaborations with Peter Kese, and Matias Lizana is this electronic eye: A colour sensor between my eyes connected to a chip installed at the back of my head that transforms colour frequencies into sound frequencies that I hear through my bone.

(PRACTICAL PART): So this is the sound of red, this is the sound of green and this is what the sky sounds like. And you sound like this. Very noisy, very colorful.

I've had the electronic eye permanently attached to my head and I've been listening to colours non-stop since 2004. So I find it completely normal now to hear colours all the time.

At first, I had to memorize the sound of each colour, but after some time this information became subliminal, I didn't have to think about the notes, colour became a perception. And after some months, colour became a feeling. I started to have favourite colours and I started to dream in colour.

When I started to hear colours in my dreams is when I noticed that my brain and the software had united and given me a new sense. My brain was creating electronic sounds in my dreams, not the device. That was the point when I started to feel no difference between the software and my brain: the cybernetic device had become an extension of my brain - an extension of my senses. I started to feel like a cyborg: the cybernetic eye was no longer a device but a part of my body, a part of my organism. After some time it even became a part of my official image. [PASSPORT IMAGE] You are not allowed to appear with any electronic equipment on the UK passport photo, but I insisted that what they were seeing was not a piece of electronic equipment but a new part of my body.

Since I started to hear colour, my life has changed dramatically. Art galleries have become concert halls; I can hear a Picasso or a Rothko. And supermarkets have become like night clubs. I love how they sound, especially the aisles with cleaning products.

I also found out that things I thought were colourless are not colourless at all: cities are not grey (Madrid is amber terracotta, Lisbon is yellow turquoise, and London is very golden red, ...) Humans are not black and white, human skins range from light shades of orange to very dark shades of orange, we are never white or black. We are all orange.

The way I dress has also changed. Before, I used to dress in a way that looked good, now I dress in a way that sounds good. If I'm happy I dress in C major. If I'm sad I dress in a minor chord. So if I need to go to a funeral, I might dress in B minor (that's turquoise, purple and orange). Today I'm wearing C Major.

The way I look at food has also changed. Depending on how I display the food on a plate I can eat my favourite song. So, I hope to open a restaurant one day where you can have a menu with some Madonna songs as starters, some Rachmaninov piano concertos as main dishes, and some Bjork desserts. I would have some Paul McCartney songs, because I'm a vegetarian.

My sense of beauty has also changed. Someone might look very beautiful but sound terrible. Someone might sound very harmonious but look awful.

Now I create sound portraits of people. Instead of drawing the shape of someone's face I write down the different notes I hear when I look at them and then I send them an mp3 of their face. Each face sounds different. (IMAGES OF SOUND PORTRAITS)

I even give face concerts now, concerts where I play the audience faces. The good thing about doing this is that if the concert doesn't sound good, it's their fault.

After some time, an unexpected secondary effect appeared. I started to perceive normal sounds as colour too. Telephone tones started to sound green, the BBC pips became turquoise, and listening to Mozart became a yellow experience, even people's voices had dominant colours. So I started to paint the colours of music and the colours of voices.

For example: these are the first 100 notes of Mozart's Queen of the Night. (IMAGE) And this is Baby by Justin Bieber. (IMAGE)

And these are two speeches. (IMAGE) One of them is "I have a dream" by Martin Luther King, and the other one is Hitler. I usually exhibit these paintings with no labels underneath, and ask people which one they prefer. Most people change their preference when I tell them that the one on the left is Hitler.

There was a point when I was able to perceive 360 different colours, one for each degree of the colour wheel. I was able to perceive colours just as well as people with colour vision. Then I realized that the human visual system is very limited; you can't actually see colour very well; there are many more colours around us that the human eye can't detect. So I decided to continue extending my colour perception and included infrared and ultraviolet into the colour-to-sound scale.

So now I can also perceive infrared, which means I can hear if there are movement detectors in a room or if someone is pointing at me with a remote control. The good thing about hearing ultraviolet is that you can hear if it's a good day or a bad day to sunbathe. Ultraviolet is a dangerous colour, a colour that can kill us, so it would be useful for all of us to be able to perceive it.

We should all have the wish to extend our senses. If we compare ourselves with other animals, our senses are very limited. Some birds can see ultraviolet, dogs can hear ultrasounds and smell much better than us, sharks can detect electromagnetic fields, dolphins can hear through their bones, bats can see through sound... and so on.

By becoming cyborgs we have the chance to extend our perception to the level of other animal species. There's no need to create new superpowers, nature already has them. So becoming a cyborg is not about becoming like a machine, it's not about becoming less human, it's about bringing us closer to other animals and to nature; it's about awakening our senses, our instincts, our intuition... qualities that we seem to have lost due to our constant use of technology as an external tool, and not as part of our body.

Life will be much more exciting when we stop creating apps for our mobile phones and we start creating apps for our own body.

We focus so much on extending our knowledge, and focus so little on extending our senses. No matter how much I knew about colour, as long as I couldn't sense colour, colour made no sense to me.

We are the first generation that doesn't need to wait for natural evolution to evolve; we can evolve during our lifetime. Going to space is not the only option we have to explore new territories; we still have a lot to explore on our own planet if we add new senses to our body.

So I encourage you to think about which senses you'd like to extend, I encourage you to become a cyborg. You won't be alone.

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