Grounding Colour

Joost Rekveld

Colour is central to my work. It is an aspect of my images that all kinds of viewers readily connect to, the pleasure of colour creating an opening for more reflective modes of viewing. Also, as a viewer of my own work, the gratifying experience of colour in motion remains an important motivation to make it. In this text I would like to give a broad overview of the development of my approach to colour in my abstract films and installations. I will discuss examples of projects and point to some historical sources. Some of these were sources of inspiration at the time, others helped me retrospectively to understand what I was doing and prepare for next steps. A common thread through these projects and references is that they represent different ways to anchor decisions about colour: in our experience of daylight, in an analogy to music, in our perceptual system, and finally, in our tools for modelling and manipulating physical manifestations of colour. Taken together they show a gradual shift in my underlying interests: from developing my own tools and systems for composing colour, to an interest in the act of toolmaking itself as a process of formalization and conceptualization, colour remaining the medium of choice.

Day and night colours

I started to make films out of admiration for the films in the tradition of what is now commonly called 'visual music'. In the early nineties, the only way to see these experimental films was to organize film screenings and travel to see film screenings organized by others. Seeing the films by filmmakers such as Oskar Fischinger, Hy Hirsch, James Whitney and Jordan Belson made me see colour in the world around me and those experiences of colour became the inspiration for my first film, *#2* (1992).

Whereas the musical instruments for auditory music are ready at hand as the result of thousands of years of cultural evolution, this is not the case with visual music. Similar to electronic music, composers of visual music often develop their own tools, notation and musical language as part of their process of composition. I wanted to make *#2* on film, and the only image-manipulating instrument to which I had access was a contact printer built to make copies of super-8 films. Most of the images in the film consist of visual textures constructed by layering copies of the same super-8 sequence on top of each other, slightly shifted in time

and using different colour filters for each layer. In the layering of the colours I tried to achieve a range of effects going from subtle variations that resemble the sudden shifts in tone that can happen when clouds pass in front of the sun, to the more saturated colours I associated with dusk and dawn but also with synthetic light and film. The colour choices in this film were very associative; it was the idea of colour changes during the day, more than actual analysis of them, that served as the starting point for this film. I was looking for a foundation for my colour choices and convinced myself that our colour experience must be rooted in the affective power of atmospheric colours, and especially the colours of dawn and dusk. Much later I found a somewhat cryptic quote by visual music pioneer Mary Hallock Greenewalt (1871-1950) that seems to capture a very similar mindset:

> From midnight darkness to midday brightness has been a scope playing on the emotional development of man in a natural state. This formed a basis for the artificial, in other words, for this form of fine art speech. (Hallock Greenewalt 113)

Hallock Greenewalt is a good example of the heroic and often also tragic pioneers that make up the early history of visual music, such as Alexander Wallace Rimington (1854-1918) and Thomas Wilfred (1889-1968) just before and after her. Greenewalt was a classical pianist of a certain fame and developed her art of light at first as a possible visual accompaniment to her piano recitals. In the course of several years she designed and built various devices to modulate and control electrical light, leading to the first private demonstration of her colour instrument at the Capitol Theatre in New York in 1921 (Klein 21). She invented a very interesting interface to control lights as a form of live performance, together with the equivalent of a musical notation, in order to conceptualize and record her colour compositions. Her version of colour music was an art that resembles dynamic theatrical or architectural lighting, using several light sources arranged in spaces such as concert venues or churches, capturing as much of the field of vision of the audience as possible. What is remarkable about her ideas is that they focus on the psychophysical notion of “least perceptible differences” in light intensity and colour, and that especially the articulation of light intensity was a central aspect in both her notation system and the design of her interface. The main element in that interface was a very large and very finely graded linear commutator, calibrated in the smallest perceptible steps of intensity from 'starlight' and 'moonlight' via 'auroral' all the way to 'diurnal' and 'zenith' (Hallock Greenewalt 307-310).

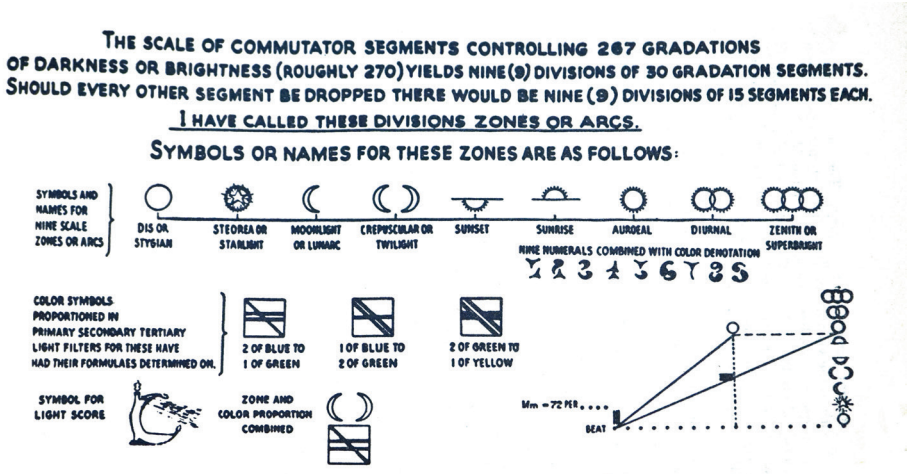

Fig. 1. Notation for light intensity by Mary Hallock Greenewalt (1946)

Colour scales and colour spaces

My next film was a result of my studies in electronic music composition and especially my encounter with the person and conceptual world of John Cage. In 1989 he was a visiting composer at the Conservatory where I had just started studying, straight out of secondary school. His lingering influence led me to apply serial music procedures to the parameters of my animation techniques on the one hand, and to leave other aspects of my films open to systems that are not deterministic on the other hand. Film *#3* (1994) was a very important film for me because in it I developed an approach that I still use, which also manifests itself in how I treated colour. I started to use notation not only to write compositions down, but also as a tool to generate and extrapolate ideas. What remained of my previous approach was a sense of the film as an abstract narrative of evolution but the development of colour was formalized into a sequence of five basic colours. The images in *#3* are the result of the orchestration of this sequence, through the combinatorics made possible by working in multiple layers and sections.

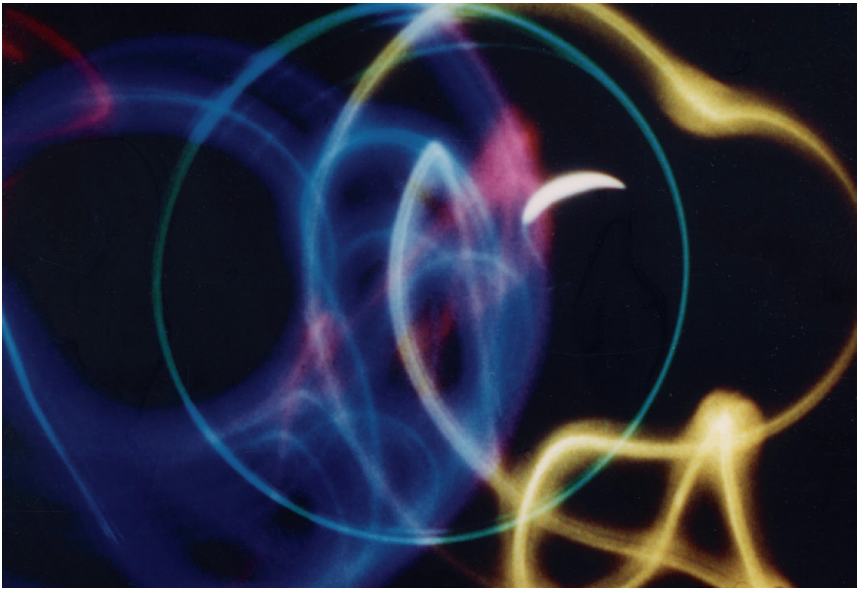

Fig. 2. Still from film *#3* by Joost Rekveld (1994)

In the history of visual music, the archetypal formulation of a fundamental colour scale was triggered by Isaac Newton's *Opticks* (1704). Newton had drawn the first colour circle after his discovery of the decomposition of sunlight into the solar spectrum. He chose this circular form because of earlier circular representations of the diatonic scale in music, in connection to the fact that he distinguished seven colours within the spectrum (Gage 232). He linked these seven colours to the seven tones in the octave and to the seven planets known in his day, and in query 13 at the end of his *Opticks* he speculated on a possible common vibratory origin of colour and tones.

In 1725, Louis-Bertrand Castel suggested building an instrument, the *Clavecin Oculaire* (Castel 1725, 255-257), to demonstrate his improvement on the colour-tone correspondences proposed by Newton. Castel's life seems to have taken a particular turn as a result of the fame he acquired following his idea to actually perform a *musique muette* of colour variations in time. In follow-up articles he expanded on his idea, sketching what a music of taste could be like, or for instance a music of touch. More than a decade later he started serious attempts to actually build an ocular harpsichord, succeeding to some extent, but also leading to bitter complaints at the end of his life that he wasted too much money and time chasing this vision.

In one of his earlier follow-up articles Castel attempts to make the analogy between colours and tones more precise "in the manner of geometry" and expands on the notion of harmonious and unharmonious intervals (Castel 1726, 277-296). According to him, colour combinations are more or less pleasant depending on the simplicity of their ratios of vibration on the retina, similar to musical intervals. Already during Castel's lifetime, the science behind such a Pythagorean view of colour harmony was thoroughly disproven (Franssen 42-44). Moreover, when applied to Castel's colour scale, it leads to counter-intuitive implications claiming that complementary colours are actually harmonious and combinations of adjacent colour-tones such as red and orange inharmonious. Later in his life he departed from strict analogies with music in his conviction that all colour harmonies had a *basse fondamentale* that was absolute; it consisted of the colour blue because we see all colours against the background of the sky.

I developed my own approach specific to composing colour relationships in the process of making my film *#7* (1996). The images in that film were produced by stamping transparent dyes on clear 16mm film leader and using the resulting painted film as a negative to make film prints. One reason to use this technique -

apart from it being exceptionally cheap - was that the mixing of dyes allowed me to precisely manipulate colour. I was attracted by the interplay between the additive primary colours red, green, blue and the subtractive primary colours yellow, magenta, cyan that this method implies; using painted film as a negative as it were converts paint into light and one triad of primary colours into the other. This interplay I found represented very elegantly in the colour space invented by the German colour scientist Harald Küppers and described in *Die Logik der Farbe, Theoretische Grundlagen der Farbenlehre* (1976).

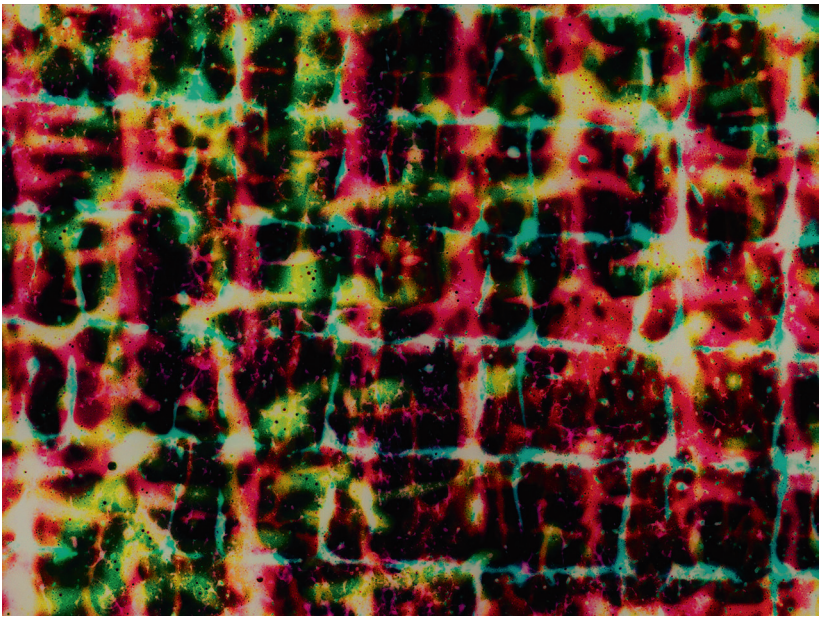

Fig. 3. Still from film *#7* by Joost Rekveld
(1996)

As in other three-dimensional colour models by Runge or Munsell, the central vertical axis runs from black to white, but in the model of Küppers the additive and the subtractive primary triads are given separate levels. This model visualizes very clearly the fact that white light minus two subtractive primaries yields an additive primary and that darkness plus two additive primaries yields a subtractive primary. All human colour is grounded in the fact that the human retina contains elements with three different spectral sensitivities but many other aspects of colour are dependent on context and culture. I needed a model to work with colour and for this I was less interested in a model that describes the particularities of colour perceptions in narrowly defined circumstances. What I needed was a colour model that describes operations such as mixing light and overlaying filters.

The starting point of film *#7* is the idea that colours arise from the clash between light and dark, an idea that was already mentioned by Aristotle, and that was later restated by Goethe, amongst many others (Kemp 264). The film is essentially a slow fade from black to white, travelling through Küppers' colour model from bottom to top. The colours for each section of the film are taken from an equal division of the perimeter of the colour model at the respective height, most of the time only using a selection of those colours, so that the sections can have very different colour palettes. With this system I could orchestrate the colours of the many layers of paint in that film.

#7 was perhaps the most ambitious and articulate colour composition I made, and in retrospect I think that making that film was necessary for me to be much freer in the colour compositions for later projects. For those later projects I still often use the Küppers colour model as the colour space but with specific constraints or palettes that fit the project. For my film *#11, Marey <- Moiré* (1999) for instance, the images were made by combining high-contrast black and white positives and negatives in several layers and with different colour filters for each combination. In this way, the whole image can be coloured in four distinct regions by the four possible combinations of the positives and negatives of two originals. With three originals there will be eight possible combinations, and so on. For this film I developed a kind of colour logic based on what happens when two colours meet. In some sections of the film, the line patterns that comprise the film behave like beams of light, whereas in other parts they behave like overlapping filters, culminating in parts of the film where the colours that appear do not correspond to anything we know from physical interactions of objects.

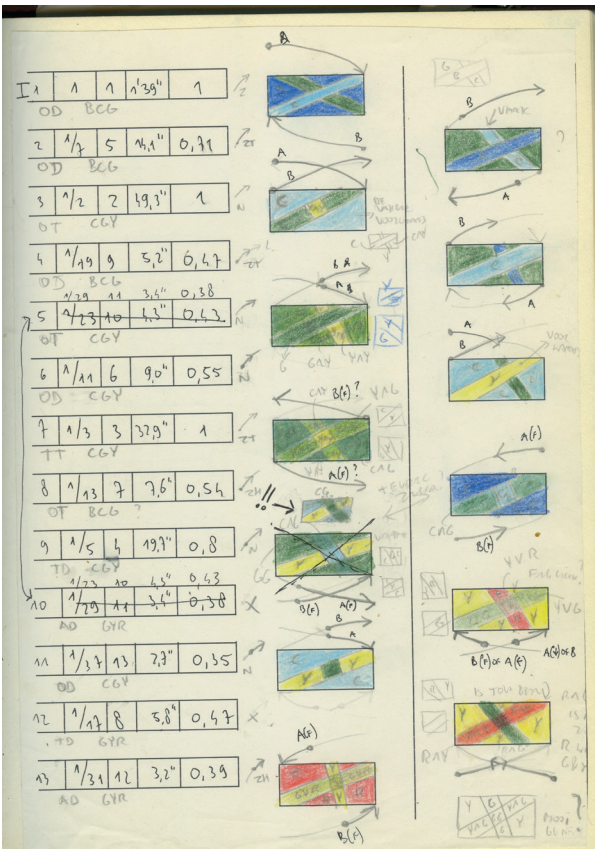

Fig. 4. Work notes with colour logic for film *#11, Marey <-> Moiré* by Joost Rekveld (1999)

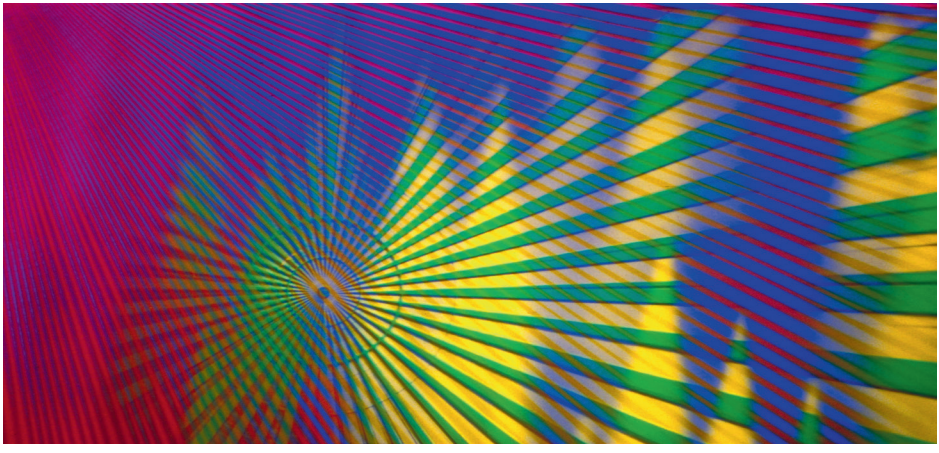

Fig. 5. Still from film *#11, Marey* <-> *Moiré* by Joost Rekveld (1999)

Another project was the light installation *#31, RGB* (2001) that I made in collaboration with Gerard Holthuis. This installation consisted of 80 dimmable fluorescent lights in the colours red, green and blue, arranged in a curved shape in a space that was completely painted white. The intensities of the individual lamps were controlled by software and the composition consisted of a number of situations characterized by different speeds and spatial patterns of colour change. The main factor in composing the colours for this installation was the fact that the lamps themselves are always on and always look a rather pale red, green or blue, while the light mixtures in the space could be extremely intense and saturated. The composition exploited the different possibilities of this contrast between local lamps and the total field of colour in the space.

Fig. 6. Installation view of *#31, RGB* by Joost Rekveld and Gerard Holthuis (2001). Photo by Hein van Liempd

Air colours

In recent projects I have become curious to explore particular colour systems that are inherent in a certain physical phenomenon or material. Two of these projects are the collaborative audiovisual performance *Ursae Minoris* (2017) and installation *#73* (2019), both inspired by a beautiful little book that I found by accident: *Luft-Farben*, a short monograph about the colours of the sky from 1912. The author was Albert Heim (1849-1937), a Swiss geologist who in this book admits he is no expert but who developed an interest in atmospheric optics through his fieldwork in the mountains. It contained explanations for many phenomena that were new to me. For instance, he explains the blue colour of the sky, caused by scattering of the light from the sun, in a detailed comparison to how light travels through water that is not completely pure. He also talks about the changes in ratio between direct sunlight and light scattered in the air, and about how the shadow of the earth travels through the atmosphere, relating this to the variously coloured phases of dusk and dawn. And he complains about air pollution, which seems rather astonishing for Switzerland in 1912.

Fig. 7. The cover of Albert Heim's *Luft-Farben* (1912)

Through Heim's descriptions, one gets a sense of air as a medium around us, influencing and partly causing the colours we perceive. This is a perspective that is very different from looking at the coloured sky as something that is always 'up there' or 'out there' at the horizon. That difference in perspective is perhaps the strongest at the end of the book, when he talks about 360-degree rainbows one can see in fog and rain in the mountain, experiences most of us now tend to have in planes rather than on mountain tops.

Ursae Minoris was a collaboration with composer Claudio Baroni and double-bass performer Dario Calderone, based on a musical score that is the result of an idiosyncratic translation of star maps. My visual contribution to this project was inspired by Albert Heim. I was looking to simulate phenomena that result from interactions between light and air molecules, small waterdrops and ice crystals.

I was thinking to use one very poetic historical moment as a starting point: the theory of the rainbow by Francesco Maurolico in his *Photismi de lumine etc. etc.*, written around 1523. This text is the first explanation of the rainbow that considers the internal reflections of light inside each raindrop and Maurolico assumed that the light reflects eight times. This then explains the octave of colours produced as well as the angle of approximately 45 degrees at which the rainbow is visible. In the end I built a software instrument based on the mathematical model made by Gustav Mie to describe how electromagnetic waves are scattered by small spheres. Our current understanding is that the colours of the rainbow are produced by the interference of light waves as they are diffracted by raindrops. This was first formulated by Thomas Young, mathematically described by George Airy in 1838, and subsequently refined by Gustav Mie (1868-1957) at the beginning of the twentieth century, which is why it is still referred to as Mie-scattering.

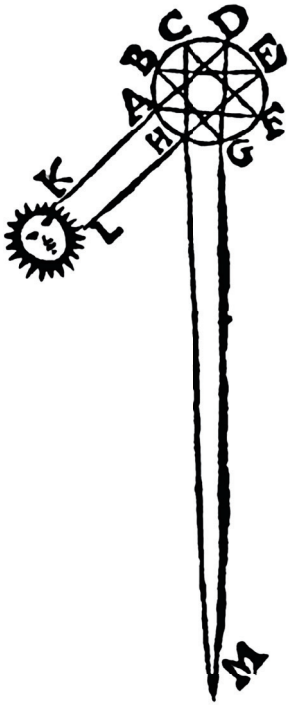

Fig. 8. Diagram explaining the rainbow from the 1611 edition of Francisco Maurolico's *Photismi de lumine etc. etc.*

The visual material that results from this is to some extent summed up in the 'Lee Plot' in figure 10; a diagram of colours and light intensities that has a visual angle relative to the sun on the x-axis and the logarithm of the size of the waterdrops on the y-axis. The angles run from 90 degrees on the left to 180 degrees on the right, and the drop sizes run from the finest drops that can be found in fog to drops that are about one cm in size. The vertical line a bit to the right in the lower half of the plot corresponds to the primary rainbow we most often see in the sky, the other vertical line corresponds to the secondary rainbow, and the dark band between them is Alexander's band.

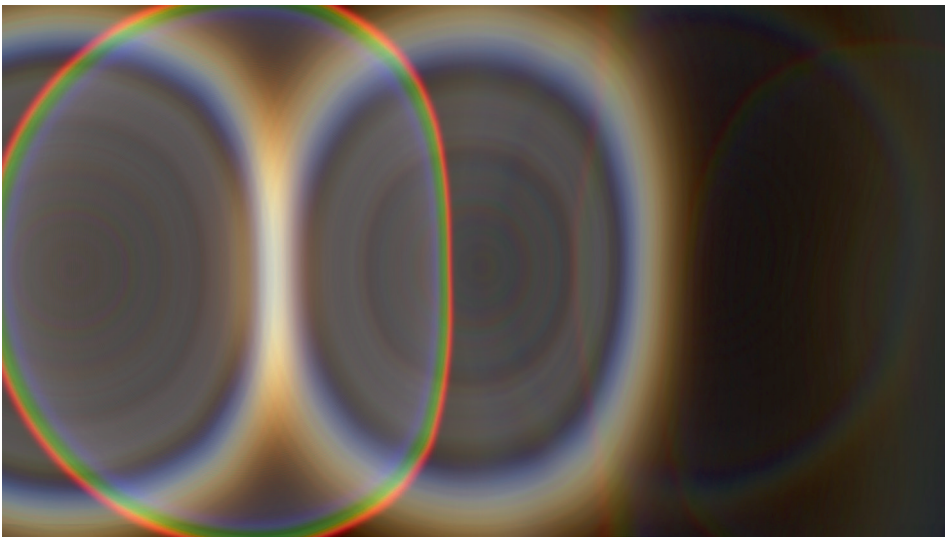

Fig. 9. Still from *Ursae Minoris* (2017), live projection by Joost Rekveld

If we would zoom in, we would see that these two 'rainbows' are accompanied by many small echoes that become larger and fuzzier as the drops get smaller; the supernumary arcs. What I like in this colour-space are the non-linear and very unpredictable interference patterns that arise, for instance, with very small drops. This is what theoretically could happen in fog but the variations in drop size in real fog are normally much too large for these phenomena to actually occur. Composing in such a colour-space becomes similar to devising a guided tour along the most interesting sites in a landscape. We performed *Ursae Minoris* at a number of music and film festivals, as well as in a number of small planetaria. With the same software I later made the monumental installation *#73*.

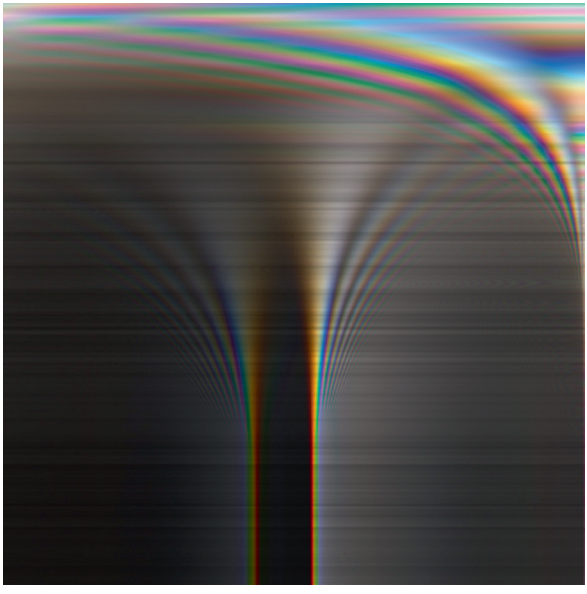

Fig. 10. A 'Lee plot' diagram showing colour as a function of angle with the sun (X) and log drop size (Y)

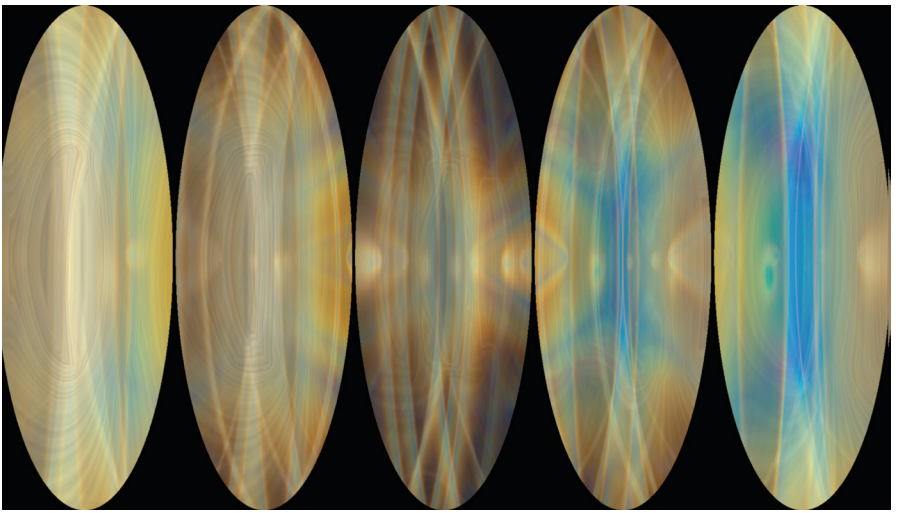

Fig. 11. Five screens overview of installation *#73* by Joost Rekveld (2019)

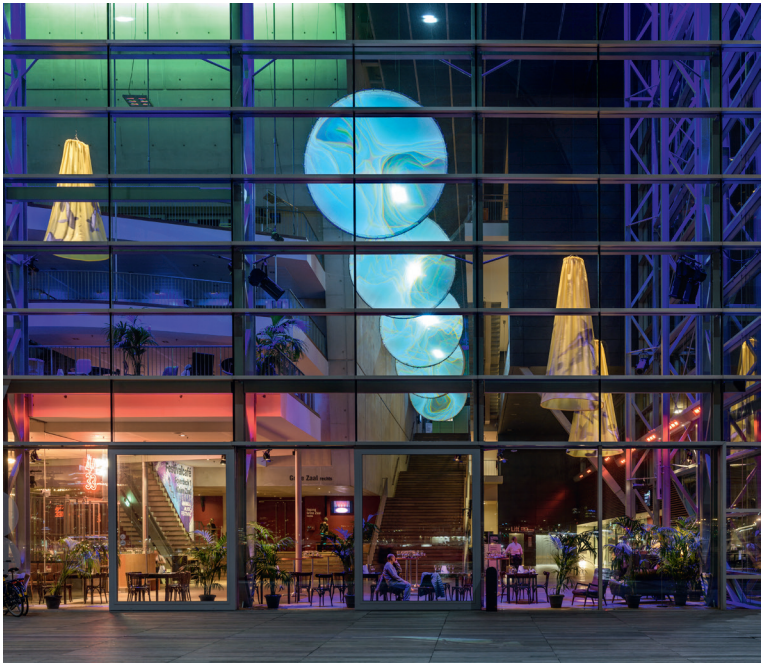

Fig. 12. Installation view of *#73* (Muziekgebouw Amsterdam, 2019). Photo by Pieter Kers

A very recent project takes this fascination with found colour spaces a step further by starting from a historical artefact. My installation *#71.1* (2019) is an early tangible result of my research of the past few years into analogue electronics. I have become interested in the early history of analogue electronics as a way of looking back at the origins of our current thinking about computation, simulation and control. One way this interest manifests itself is in experiments with cathode-ray tubes. These were invented by Braun already in 1897 and are the direct ancestor of the radio-tube, the display tube used in radar and television, the particle accelerator, the electron microscope and the lithographic devices that produce most of our current nanoscale electronics. It was the first device in which electrons could be controlled, as a way to amplify and control signals, or as a way to direct energy. In a vacuum, electrons behave similar to light, focused and deflected by electric and magnetic fields instead of lenses.

#71.1 is the first in a series of works that aims to explore this analogy and brings us closer to the particles that form the substance of electronics. In a cathode-ray tube, electrons are made visible by their collisions with the phosphor on the inside of the screen. In this first installation, I chose a particular kind of tube that was developed for radar in early 1939, just before the second World War (Keller 71). These tubes have a special phosphor that shows current signals as bright blue, with a very long afterglow in yellow-green, so that the past and current locations of planes on the radar screen can be clearly distinguished. The quality and presence of these phosphor colours are very beautiful and it is very interesting to work with the quirky and severely limited colour space inherent in this material.

Grounding

The gradual change in my thinking about colour reflects a change in the question that drives my work. When I was making my first films, I very much felt part of the tradition of visual music. Informed by contemporary music and structural film, I was trying to develop my own way of composing moving abstract images in time. I tried to develop a form of visual music that was at the same time a reflection on the medium, and *#11, Marey <- Moiré,* was an important work in that respect. In film *#3* I had started to compose by structuring the space of possibilities opened up by the tools I was using. While making *#11* I realized that these tools are also cultural artefacts, embedded in a technological and scientific culture, carrying their own meanings and political connotations. Experimental film has always been political, being defined in opposition to a film industry and in its attempt to explore alternative cinematic languages.

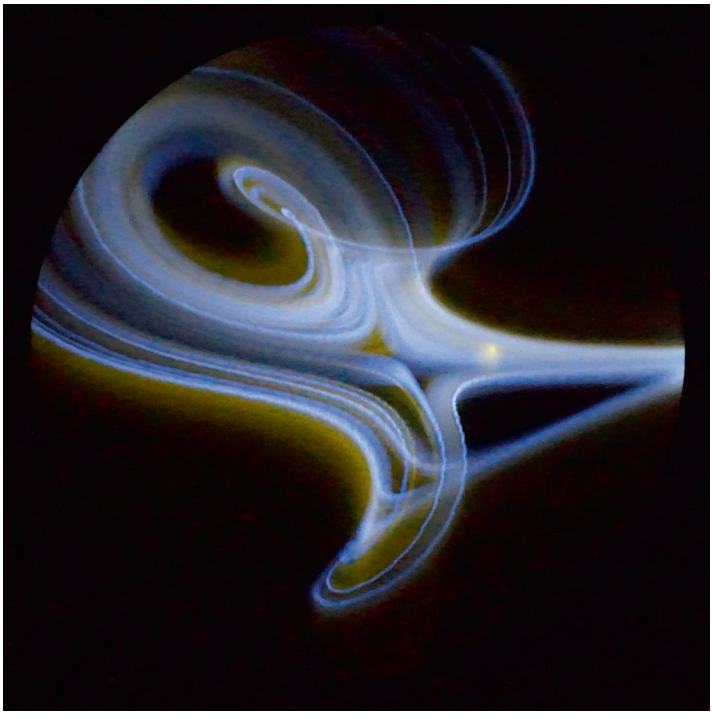

Fig. 13. Still from installation *#71.1* by Joost Rekveld (2019)

On a deeper level, I realized that the origin of the medium of film is also the origin of the assembly line and of the concept of scientific management, and that any technology comes with similar meanings. In my work I have always been looking for some kind of foundation, defining my building blocks before starting to build compositions out of them. One obvious way to do this is to retrace a genealogy, which is one of the reasons why I am interested in history; choosing a point of origin opens alternative possible trajectories. After *#11* I started to focus on genealogies of scientific theories and technological objects rather than on artistic precursors.

Leroi-Gourhan has a beautiful description of technology as a 'curtain of objects' through which we assimilate our surroundings (Leroi-Gourhan 353). This thin film of clothes, houses and tools is the interface between our inner world and the exterior world and defines us just as an amoeba is defined by its cellular membrane. Thus, while I started out making work as a modernist, looking for solid ground, I am now mostly interested in probing the curtain of technological objects with which we articulate ourselves. No longer a question that is directly related to colour therefore, but in its peculiar combination of physicality and weightlessness, colour still seems a great medium to do so.

Works cited

Castel, Louis-Bertrand. *Clavecin pour les yeux, avec l'art de Peindre les Sons, & toutes sortes de Pieces de Musique*, Mercure de France, 1725.

Castel, Louis-Bertrand. *Demonstration Geometrique du Clavecin pour les yeux & pour tous les sens, avec l'eclaircissement de quelques difficultez, & deux nouvelles Observations*, Mercure de France, 1726

Franssen, Maarten. "The Ocular Harpsichord of Louis-Bertrand Castel, The Science and Aesthetics of an Eighteenth-Century Cause Célèbre." *Tractrix* 3 (1991): 42-44.

Gage, John. *Colour and Culture, Practice and Meaning from Antiquity to Abstraction*. London: Thames and Hudson, 1993.

Hallock Greenewalt, Mary. *Nourathar, The Fine Art of Light Color Playing*. Philadelphia: Westbrook, 1946.

Heim, Albert. *Luft-Farben*. Zürich: Hofer & Co, 1912.

Keller, Peter A. *The Cathode-Ray Tube; Technology, History and Applications*. New York: Palisades, 1991.

Kemp, Martin. *The Science of Art, Optical Themes in Western Art from Brunelleschi to Seurat*. New Haven: Yale, 1990.

Klein, Adrian Bernard. *Colour-Music, The Art of Light*, second edition. London: Crosby, Lockwood and Son, 1930.

Küppers, Harald. *Die Logik der Farbe, Theoretische Grundlagen der Farbenlehre*. München: Callwey, 1976.

Leroi-Gourhan, A. *Milieu et Techniques*. Paris: Albin Michel, 1945.

Rekveld, Joost. "Transformations de la Couleur." In Nicole Brenez and Miles McKane (eds.) *Poetique de la Couleur, Une Histoire du Cinema Experimental*. Paris: Editions Auditorium du Louvre, 1995.