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Seeing Sound

This report will describe the process and thoughts behind the project Seeing Sound. Seeing Sound is an proposed idea for an color instrument which can be applied to a concert. In this report the instrument is demonstrated at a fictional concert at The Opera House in Copenhagen. Employing the same title as Mary Ellen Bute's series of abstract animation films, this project will try to produce an abstract animation film of audience generated sounds visually represented through a constructed color and shape system, influenced by color music theories of Alexander Scriabin and Wassily Kandinsky, and inspired by the animation technique of Norman McLaren. Lastly the audience experience and reward will be mentioned.

Musical Experience
Supervisors:

Design 3:3 – The concert's live format
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Content

Introduction

Seeing Sound is an interactive sound and image experience. As audience going to a concert, visitors have the opportunity to be a part of an abstract film of sound, shape, and color. In the foyer space before the concert visitors find an instrument formed as a basic keyboard. Each key contains a color. Once a key is pressed the music note linked to the color is heard. While visitors play the keyboard, the music is stored as midi[1]. It becomes evident for visitors that they are making colors by playing, each color is the result of a distinctive touch. A short text explains and instructs the visitors about the project.

After the concert the midi is collected and become the basic building blocks of an abstract film. The midi is converted into sheet music [Ill. 2]. Each note, still connected to a specific color, is given a certain shape. Following this principle, the sheet music is transformed into a visual notation system. Using sheets of clear A4 acetate paper and the notation system, music notes are animated, by hand, note by note.

Two weeks after the concert, and when done, the finished abstract film is returned to the participating visitors along with a letter containing additional details about the process from sound to image. The visitors can enjoy the abstract film and, if interested, dive into layers of audio visual information and project research.

Seeing Sound builds upon the challenges and experiences of the Musik2Go concerts (no 3 and no 4) held at The Opera House in Copenhagen in April and May of 2014. The concerts was made by a group of students from the Royal Danish Academy of Fine Arts School of Design in cooperation with students from Medea and teachers Arthur Steijn and Jakob Ion Wille. These concerts attempts to use audience involvement to bring new perspectives on classical music. It also aims to explain the use of the musical instruments through hands-on experiences. The theme of Musik2Go concert no 4 was Color Music as it tried to explain the parallel between colors and tones throughout history.

This project will continue the same exploration and create an instrument and an abstract film, that is intended to be part of a unspecific concert with the theme Color Music. It focuses solely on this particular interactive item, and it's results, and disregards the remaining design of the concert as well as the further concert experiences of the visitors.

1 Midi makes it possible to send digital data from one device to another. Instead of recording a analog audio output from an instrument, like an electric piano, data is send containing information about notation, pitch, volume etc. On the computer this data can be altered and changed without losing the original information.

Preliminary thoughts

Seeing Sound gathers a number of interesting investigations in examining audience involvement, transformation of one form to another, animation technique, and sharing. From this some questions arise:

How can audience create audio content?

How should this content be used in creating an abstract animation film?

What are the challenges in sharing the abstract film after the concert?

These questions also divide the project into three parts.
Here are some initial thoughts on each section:

First, the audience interaction with the instrument should be simple and only demand a short period of time and little effort from each visitor. This will hopefully result in a larger number of visitors participating.

Second, the level of audience influence in the abstract film should be questioned. If all the elements of the film is directly visitor produced, the graphical quality of the film might be low. If the designer instead creates every element unaccompanied, the connection to the audience might be lost. In this case, the intention is to produce a film that utilize the visitors input, but still relates freely to it, in order to keep the audio and visual qualities of the film high. The other sizable question, is how to alter the visitor generated tones into (a) visual matter (b) suitable for abstract animation. Historical theories relating music, color, and shape could contribute to this conversion. Moreover, would it attach the abstract film to the theme of the concert.

Finally, the high level of qualities will, supposedly, lead to an abstract film that visitors wants to share, when receiving it two weeks after the concert. The question regarding communicating the film is also engaging. Should the release be broad or narrow? and how should the visitors be addressed? Then comes the issue, if the film should be supplied with information, that attempts to interpret the content of the film, for the visitor, in an effort to describe the overall theme of Color Music.

Color Music

The seek to identify a connection between tones and colors is properly as old as the categorizing of sound. When Pythagoras found the "perfect" fifth interval[2] he harmonized and thereby, to a certain degree, visualized music[3]. Later Aristotle saw a correspondence between colors and sounds that entered into music[4] (Poast, 2000).

2 Which consists of seven semitones, e.g. the distance from C to G. It forms the diatonic scale in classic music theory and can be found as the white notes on a piano: C–D–E–F–G–A–B (Erlich, 1998).

3 In finding the ratios between frequencies, the tones became mathematically visible.

4 The seven tones in the diatonic scale was linked with the seven known planets at the time (Jewanski, 2014).

Since the renaissance, scientists, composers, and artists have been investigating and debating (a) if there was a definite correlation (b) how the two elements was linked and (c) in which manner the connection should be explained. Through his optical experiments, Isaac Newton related the tone intervals in the musical scale with light's wavelengths in the color spectrum (Tsang, 2008). Newton described the relationship as a natural scientific law, while others focused on the emotional experiences in the perseveration of tone and color.

This new subjectively interpretation also gave birth to the idea of constructing instruments to demonstrate how tones was perceived in colors. Louis-Bernard Castel applied color theories of painters, instead of those of Newton [Ill. 5], and in 1734 he first attempted to build a color organ (Jewanski, 2014). The instrument named Clavecin Oculaire was composed of sixty small colored glass panes. When played by pressing a keyboard, light would shine through the panes and display a combination of colored lights (Scoates, 2013). The fascination of color organs continued and in the late 19th century, inventors like Bainbridge Bishop and Alexander Wallace Rimington builded some of the extensive color organs to date.

The popularity of music concerts accompanied by color organs, grew through out the beginning of the 20th century, and composer Alexander Scriabin and painter Wassily Kandinsky started experiments of their own (Campen, 1997). Both reportedly experienced synesthesia[5] or some degree of synesthesia (Berman, 1999). For his music piece Prometheus: The Poem of Fire (1910), Scriabin wrote notations for two types of instruments: the musical instruments of the orchestra and a score for a color organ. The intention was to enhance the awakening of the audience emotional response, by revealing the musical and visual piece simultaneously (Poast, 2000). The combination of colored lights, played through the performances of Prometheus, was based on a tone to color design made of Scriabin's own experiences of synesthesia [Ill. 4a–f]. Once again the method of connecting individual notes to colors on a color wheel was used: pitch was matched with color. Comparing his color wheel with other proposals in history [Ill. 5], it is somewhat apparent that the colors are picked through an entirely personal approach.

Looking at paintings, and the titles of them, by Kandinsky suggest a strong link between music and the visual art on the canvas. Titles like Improvisation or Composition indicate, that the painting is created similar to a musical piece. In studying shapes and patterns in these compositions, the influence of musical notation systems appear to have been an inspiration for Kandinsky. With other artist at his time, he explored his synesthetic experiences and strived to present a coinciding of color, sound, and dance (Campen, 1997). Kandinsky ordered colors according to their spiritual significance and believed that color could directly influence the human soul (Selz, 1957).

More interestingly, he studied form, basic elements and mathematical rules in an attempt to develop methods for using form, line, shape, angle, and curve for artists and designers. He termed, and taught a class at Bauhaus, this set of design tool: "basic design" (Kotsopoulos, 2000).

5 This neurological condition causes the stimulation of one sense to manifest itself in a second sense, e.g. linking letter and words with colors involuntary or, as with Scriabin and Kandinsky, seeing specific colors when hearing certain tones. See (Ramachandran, 2001).

SYSTEM

Audience interaction
Arrangement of notes
Image to sound

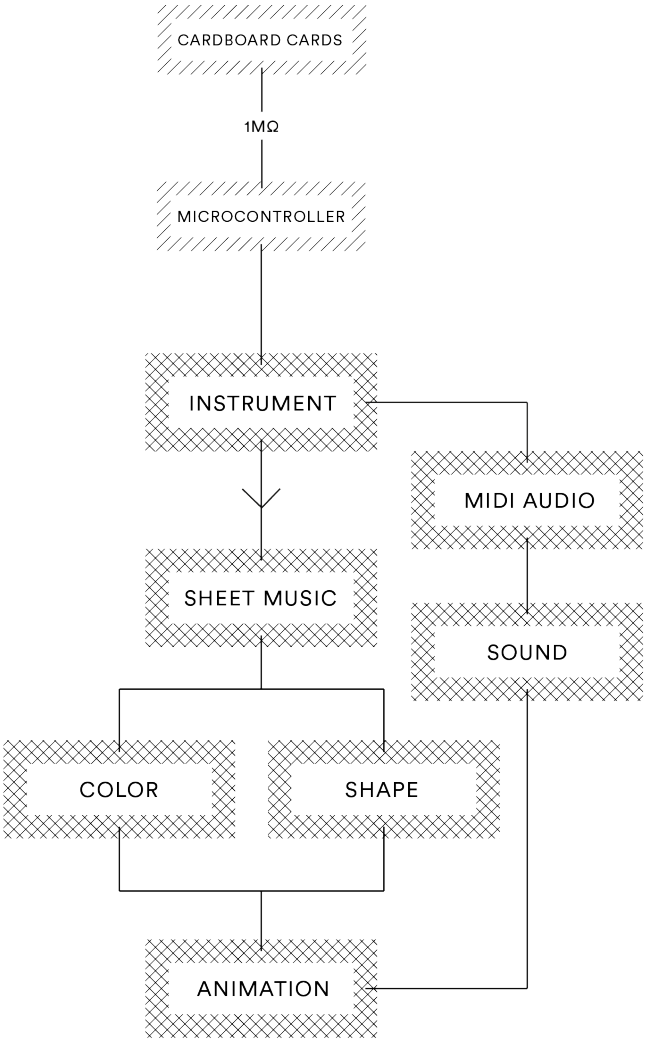
pp. 6 — 11

Ill. 1
Diagram of the process from sound to image.

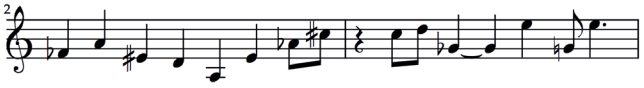
Ill. 2
Example of a line of sheet music.

Ill. 3
Photo of the midi keyboard instrument DM2000.

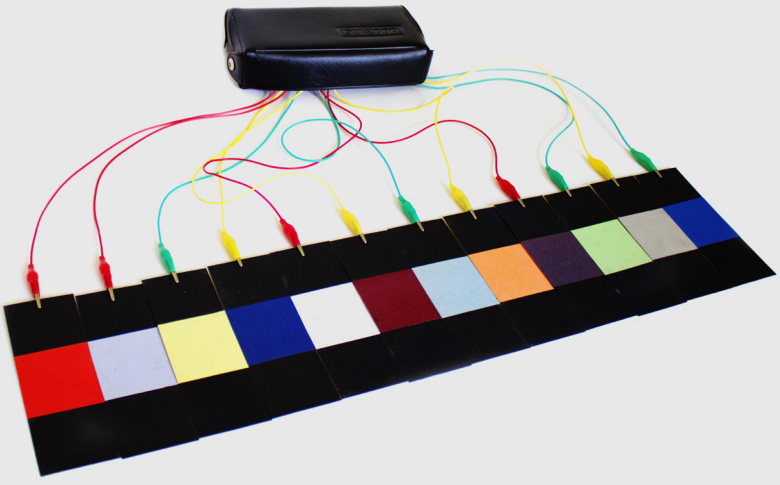
Ill. 1



Ill. 2



Ill. 3



Before illustrating how the color wheel of Scriabin and the form rules of Kandinsky's basic design, is used in an effort to establish a system to transform sound to image, the instrument should be mentioned in detail.

Instrument

The keyboard instrument is made up of 12 cardboard cards, measuring 16 cm x 6 cm, which represents the semitones in an octave between C – B [Ill. 3]. Each card is connected to a breadboard with a crocodile clip and a jump wire. From the board the 12 tones are joined to a Arduino Uno R3 micro controller, going through a 1MΩ resistor each. The micro controller is connected to a computer which is running the Arduino software. The cards are painted with electric paint, that allows the flow of an electrical current, thous enabling the cards to be used as sensors. In the software the code is written using Arduino's Capacitive Sensing Library and MIDI Note Player. As a result, the instrument collects a different signal from every card and alter it into a midi note.

Due to the function of the instrument in the project, it is build as a monophonic keyboard. This means that only one tone can be played at a time, which makes the later arrangement of sound to image, less complicated. Other than that the DM2000 can be played as an standard midi keyboard. Both software/code and the micro controller is available through Arduino's website. The cardboard cards of the keyboard reminds the visitors of the classic layout of the piano. Each card has a color label in the center of the card. The colors are picked using an interpretation of Scriabin's tone to color system [Ill. 4a–f].

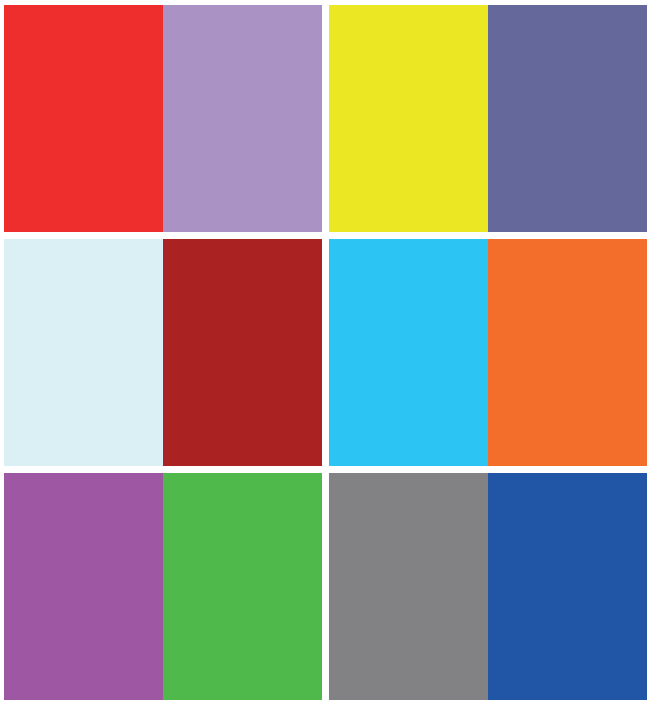
Ill. 4a–f
Interpretation of Alexander Scriabin's tone to color design made of his own experiences of synesthesia.

The twelve semitones, of the chromatic scale, are matched with colors:

C:	red
C#:	violet
D:	yellow
D#:	steel color with metallic sheen
E:	whitish-blue
F:	red, dark
F#:	blue, bright
G:	orange-pink
G#:	purplish-violet
A:	green
A#:	similar to D#
B:	similar to E

Fellow composer Leonid Sabaneyev first published this table of Scriabin's tone-color correspondence in 1911.
(Galeyev, 2001)

Ill. 4a
Ill. 4b
Ill. 4c
Ill. 4d
Ill. 4e
Ill. 4f

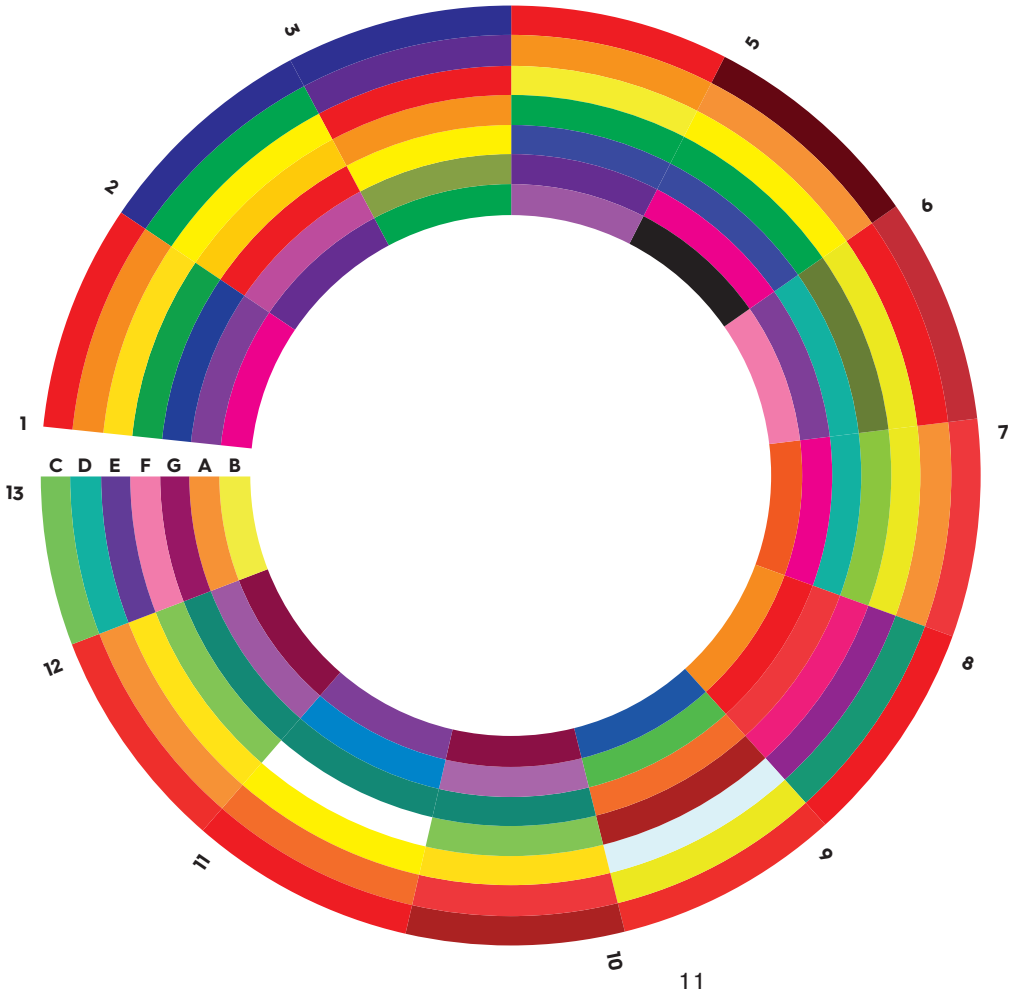


Ill. 5
Examples of the seven tones, of the diatonic scale, matched with colors thoughout history:

1
Isaac Newton
(1704)
2
Louis Bertrand Castel
(1734)
3
George Field
(1816)
4
D.D. Jameson
(1844)
5
Theodor Seemann
(1881)
6
A. Wallace Rimington
(1893)
7
Bainbridge Bishop
(1893)
8
H. Von Helmholtz
(1910)
9
Alexander Scriabin
(1911)
10
Adrian Bernard Klein
(1930)
11
August Aeppli
(1940)
12
I.J. Belmont
(1944)
13
Steve Zieverink
(2004)

Source of data: Fred Collopy.

Ill. 5



Basic Design

Inspired by Kandinsky's basic design principles, a number of shapes are constructed [Ill. 6a]. These shapes are build from the basic design ideas, but takes the colors of Scriabin.
Kandinsky talks about colors having an affinity with specific geometrical forms (Kotsopoulos, 2000). This harmonic relationship, means that the monotonous shape of the circle is compatible with the color blue. On the other hand, is the energetic color yellow fitting with the compelling nature of the triangle.
In-between shapes like the square is suitable with the color red. Following this rule, sub-forms can be created e.g. is the hexagon a mixture between a triangle and a square and consequently linked with orange. The interpretation of Scriabin's colors are used, put into these rules, and shapes are found.

Similar to geometrical forms, lines, angles, and curves also have the same affinity with colors. Illustration 7 in relation to Illustration 8, shows some of these lines, angles, and curves in action. Testing to color them is quite interesting.

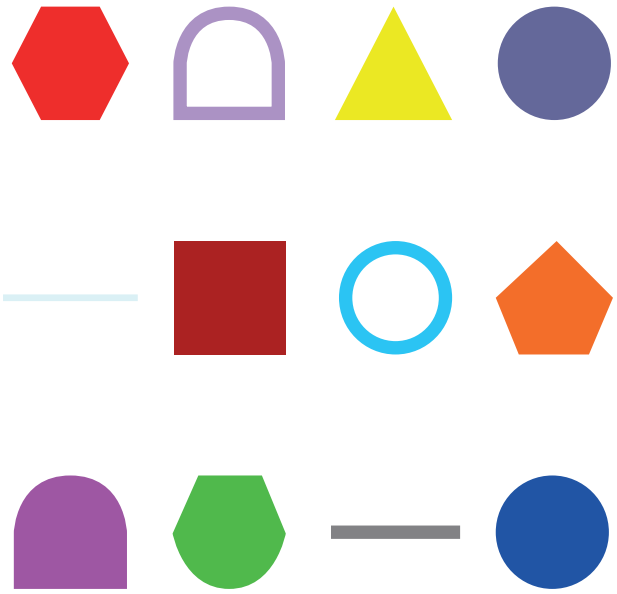
Ill. 6a
List of shapes inspired Wassily Kandinsky's basic design principles.

Ill. 6b
Two-notes sheet music with corresponding shapes noted at the top.

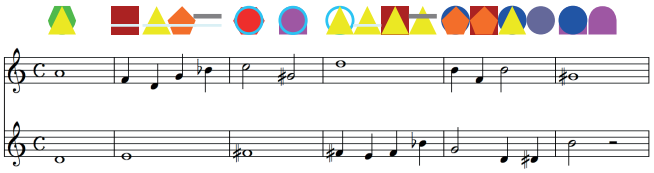
Ill. 7
List of lines, curves, dots etc. inspired by Kandinsky's drawing "Composition".

Ill. 8
Wassily Kandinsky
"Composition".
Pen and ink drawing
21 x 30 cm (1925).
Source: LiveAuctioneers.

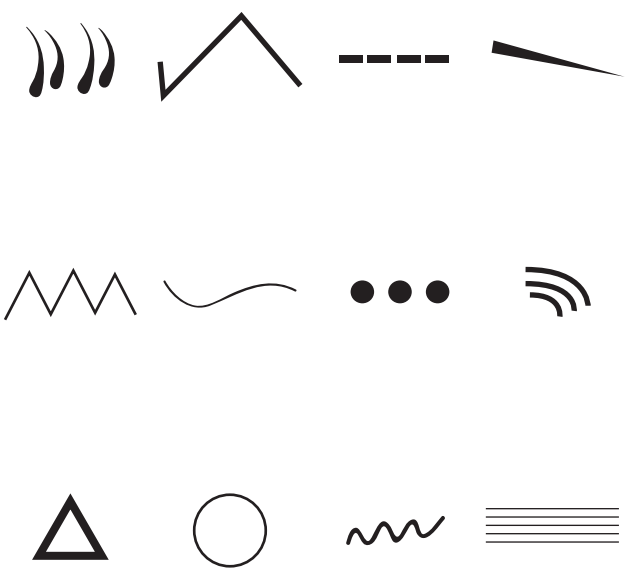
Ill. 6a



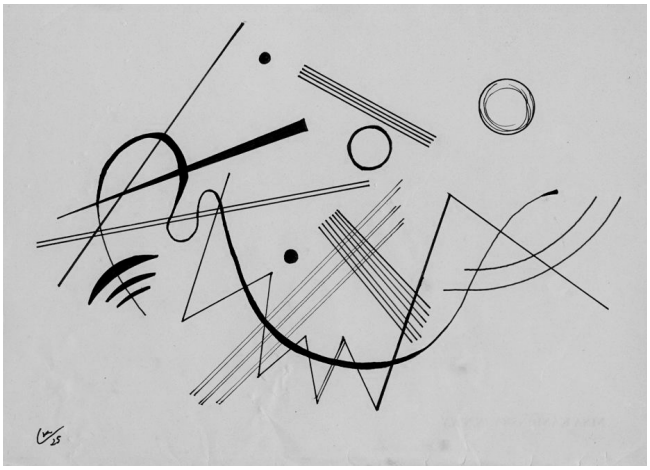
Ill. 6b



Ill. 7



Ill. 8



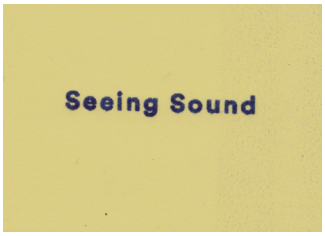
METHOD

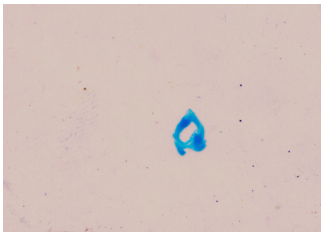
Animation technique
Image over time

pp. 12 – 17

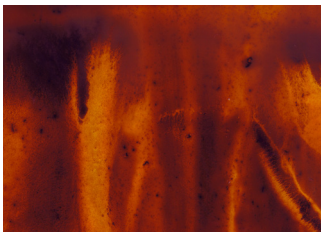
Ill. 9a–k
Film stills from Seeing Sound (2014).

Ill. 9a
Ill. 9b

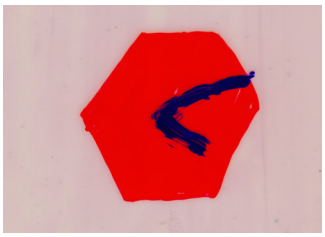




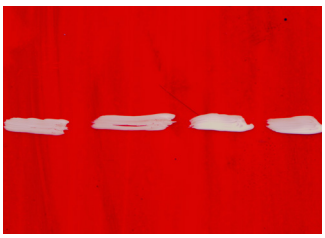
Ill. 9c



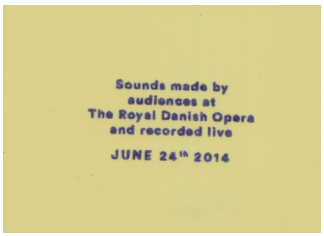
Ill. 9d
Ill. 9e



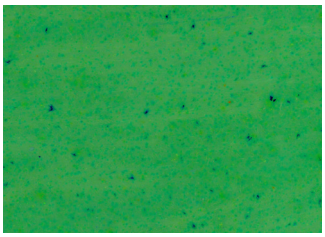
Ill. 9f



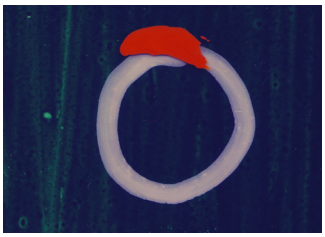
Ill. 9g



Ill. 9h
Ill. 9i



Ill. 9j



Ill. 9k

Before describing the technique involved in producing the abstract animation film, the question should be asked: what makes the animation such a strong media for expressing sound?

The abstract animation film

Subsequently to painters like Kandinsky's work, that gave visual form to music, artists began to experiment with new medias to represent sound. The extensive use and accessibility of the film in the first half of the 20th century, made this inevitably. Now it was possible to, not only accompany image with sound, but to do so over time. One of the artist that felt limited by the static two dimensional canvas, was Mary Ellen Bute. Starting in the 1930s, she made a series of short abstract animation films titled "Seeing Sound" [Ill. 10] (Lund, 2009). Bute, who had studied painting, was captured by the paintings of Kandinsky (O'Grady, 1995). After assisting color organ inventor Thomas Wilfred, working with Léon Theremin, and collaborating with composer Joseph Schillinger (Haller, 1985), Bute compiled a system for connecting audio and visual elements. To order these components over time, Bute transferred the pitch and duration of notes into a 24 frames per second coordinate system. From this, she added the positioning of the visual elements (Lund, 2009). Bute explains:

> *"I take the relationship of two or more numbers, for instance 7:2, 3:4, 9:5:4, fraction them around their axis, raise to powers, permutate, divide, multiply, subtract, and invert until I have a complete composition of the desired length in numbers. Then I realize this composition in the materials I have started to employ. I use this composition of numbers to determine the length, width and depth of the photographic field and everything in it... ...The melody, harmony, rhythm, dynamics, etc. of the sound are elaborated from the same numerical composition, thus setting up an exquisite relationship between the structural and the rhythmical interferences of the combined materials."* (Lund, 2009)

This concept might be seen in Bute's film Tarantella from 1940, where geometric forms as circle, triangles, rectangles, and squares are altered in movement, size, position, and colors through the rhythm of the music. A small section of the film features some lively dancing lines [Ill. 11a], that stands out of the rest of the visuals which best can be described as a Kandinsky composition in motion [Ill. 11b]. The lines was leftovers from another animation film, and done by animator Norman McLaren. Bute hired McLaren to do additional animation on her 1940 film Spook Sport [Ill. 12]. To create these lines, McLaren used an animation technique that omitted the use of a camera to shoot frames, as he drew directly onto clear 35mm film strips (Moritz, 1996). McLaren would continue to experiment with sound and image and evolved a method to create animated sound, by drawing sound wave patterns onto the soundtrack of 35mm film[6] (McLaren, 1953). This was obviously a fitting way to both fabricate sound and synchronizing sound and image.

6 At the edge of the 35mm film strip was printed sound waves that accompanied the film image.

Ill. 10
Film still from Synchromy No. 2 (1936). Directed by Mary Ellen Bute.

Ill. 11a–b
Film stills from Tarantella (1940). Directed by Mary Ellen Bute.

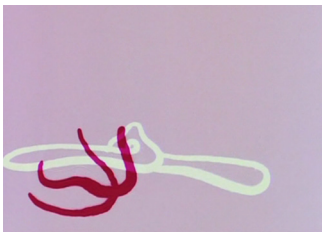
Ill. 12
Film still from Spook Sport (1940). Directed by Mary Ellen Bute.

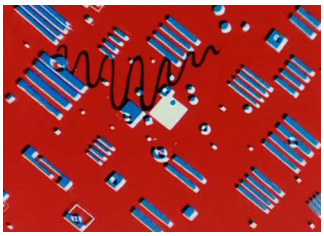
Ill. 13
Film still from Loops (1940). Directed by Norman McLaren

Ill. 14a–g
Film stills from Seeing Sound (2014).

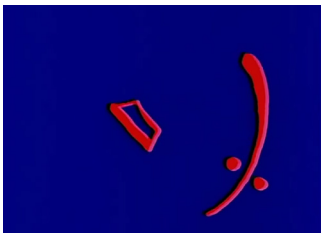
Ill. 10

Ill. 11a
Ill. 11b

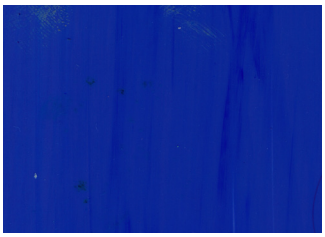


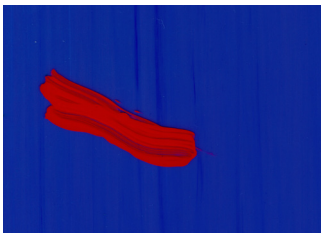


Ill. 12
Ill. 13

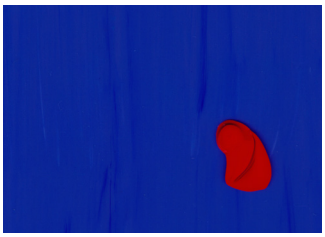


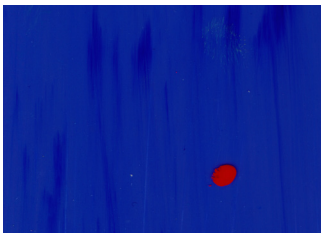
Ill. 14a
Ill. 14b



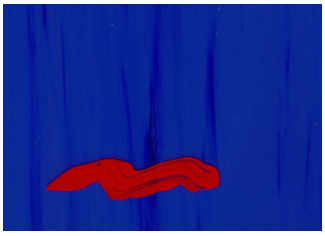


Ill. 14c
Ill. 14d

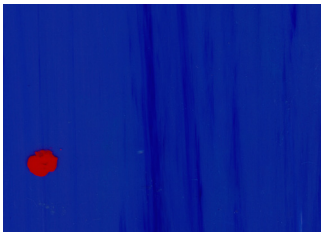




Ill. 14e



Ill. 14f
Ill. 14g



Although not visible in her films, properly due to the technical limitations at her time, Bute had a concept for relating music and color. She linked the twelve semitones[7] with twelve colors on the color spectrum[8]. To control tone, seven levels of tonal range corresponded with the seven octaves used at the piano, so that high notes would be bright and lower notes black (Lund, 2009).

There are some evident difficulties in using McLaren's hand-drawn animation technique today, the largest being the limited use of 35mm film in animation. But the basic principle of drawing onto clear film using the same tools as Norman McLaren, can simply be applied[9].

Instead of drawing directly onto film, transparent sheets of A4 acetate paper is used. Like with clear film, this ensure that different sheets of animation can be layered onto one another [Ill. 18]. On top of the acetate paper, a black piece of A4 paper with cutout frames, serve as a guide, when drawing each frame by frame [Ill. 19]. The frames measure 6 cm x 3,5 cm, and when assembled at a 30 frames per second, one sheet fits just under a second of animation.

Acrylic paints, watercolor paints, and gouache [Ill. 15] are used for both the "character" animation and the one-color sheets for backgrounds [Ill. 16]. For drawing the animation, pens and brushes are applied. Gravers are also used to scratch in acrylic painted sheets [Ill. 17].

When finished, the sheets are scanned, some individually and some layered, and chopped back into frames in Photoshop. When handling the paints and during scanning, sheets pick up tiny pieces of dirt, scratches, and hair. If the soundtrack on film made it suitable for McLaren to synchronize sound and image, computer video editing in Premiere Pro makes the task especially pleasant. Entire sequences of video are edited together and thereafter accurately sync to the sounds. Color adjustments are made to boost the original colors, and in an attempt to match the ones of the system.

7 The twelve semitones forms the chromatic scale in classic music theory and can be found as the white and black notes on a piano: C–C#–D–D#–E–F–F#–G–G#–A–A#–B (Erlich, 1998).

8 C–red violet, C#–red, D–red orange, D#–orange, E–yellow orange, F–yellow, F#–yellow green, G–green, G#–blue green, A–blue, A#–blue violet, B–violet.

9 In an interview with Alan Rosenthal, McLaren describes, in details, how he make his animation films, and which tools, dyes, paints, and inks he uses to assemble them. See (Rosenthal, 1970).

Ill. 15
Selection of acrylic paints, watercolor paints, gouache, and various pens.

Ill. 16
Assorted one-color sheets for backgrounds.

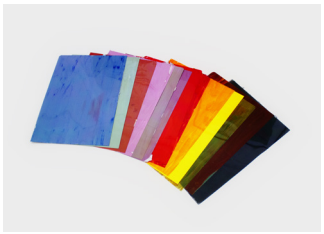
Ill. 17
Gravers and brushes.

Ill. 18
Different sheets of transparent A4 acetate paper with drawn animation, layered.

Ill. 19
Black piece of A4 paper with 21 cutout frames, measuring 6 cm x 3,5 cm, used as a guide when drawing frame by frame.

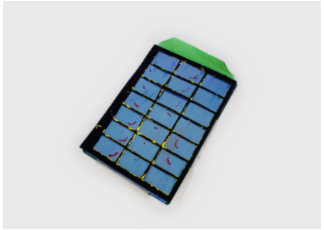
Ill. 15

Ill. 16



Ill. 17

Ill. 18
Ill. 19



SHARING

pp. 18 – 19

This section is a brief summary of the expected experience and reward of the audience.

The audience

Seeing sound tries to challenge the interaction between visitors and (in this case) the musical world of the classical concert. It is an attempt to develop an interaction piece, that will enhance the traditional audience experience.

The goal for the project is to get visitors, and viewers, interested in music, and how we as people, can not avoid to visualize music, as it works with two interactions with the audience. First the direct payoff, which the visitor encounter when playing the keyboard instrument and connecting it to the colors visible. The expected payoff lies in the future after the concert is over. In sharing the video two weeks after the concert, it is hoped, that the participating audience will respond with new energy to the almost forgotten interaction.

Sharing

There is a series of elements that models the expected qualities in sharing the final abstract animation film, (a) it is expanding the concert to long after the concert is over, thus giving the concert an longer life, (b) through an all audience viral sharing of the finished film, the film does not only become an item of the specific concert, but also works as an online promotion for future concerts, and (c) on receiving the film, it possible for the visitor to collect and read about the process of the film, it's rules, and it's inspiration, as it tries to give an understanding of how music and color has been connected throughout history.

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