

# Seeing Sound, Hearing Movement: Imposed Synesthesia

## Introduction

As technology continues to advance it is becoming increasingly possible to free up the compartmentalization of the senses. A form of synesthesia can be experienced between art forms. Cymatics and sonification are examples of such forward motion. If one wishes to see what music sounds like they may do so through a cymascope or tonoscope. If another wishes to hear what a building sounds like, they might sonify the data. Gesture control technology makes it possible to map movement and sound, among many other applications.

Open source code can be found just about anywhere online and research abounds. But, what about mapping a persons movement to sound based on the physics of sound waves and even the geometric patterns that sound creates when moving through a substance? What if that substance were a human body in motion? Alternatively, what if motion was the creative force behind the creation of sound itself. Is there a way to map a space with objective parameters, turning a stage or room into an instrument that plays music as a person moves through it? Can there even be “objective mapping” at all?

## Aims

I am attempting to configure a real time performance, installation or recording/video of viable mapping parameters, arrived at through math and science. The criterion would be applied to a 3D space using kinesthetics as the input and music as the output and/or music or voice as the input and 3D cymatic images as the output all in real-time.

## Objectives

- Gather a bank of 2D and 3D cymatic images of the 12 tone chromatic scale. (“J.J. McGowan- Modelling, Dynamics, Compositing, 3D Generalist”, J.J. McGowan, 2014)
- Attempt to apply the *The Geometry of Musical Chords* (Tymoczko, 2006) as an objective mapping strategy as movement creating music and look at Laban’s “Space Harmony” as mapping for a dynamic control layer.
- Attempt to apply the physics of sound as a cymatic “bubble” (“The Physics of Sound”, John Stuart Reed, 2015) as mapping strategy for visualization.
- Explore the most efficient way to use existing technology & programs such as Wekinator, Max, Ableton Live, Kinect, Leap Motion and VDMX Quartz Composer to generate sound from movement and images from sound using above objective mapping.

## Literature review

In order to keep the many moving parts of this research organized, I’ve come up with four subject categories that contribute to my analysis and exploration- Cymatics,

Sonification, Mapping and Technology. Listed below are some of the articles, sites and books I've been reviewing and a brief summary of relevance and/or support.

### 1- Cymatics

Cymatic images of various frequencies will provide a visual that may also help with mapping sound to a stage or room environment using patterns.

*Cymatics. A Study of Wave Phenomena and Vibration* Volume 1 by Hans Jenny presents his experiments with a tonoscope and explains cymatic imaging of sound waves as “vibrational phenomenon in space” (pg. 98) with both “kinetic and dynamic processes” (pg. 121). The image of a dancer as a cymatic image of the music they are moving by comes to mind. His *triadic phenomenon* inspires and shapes a threefold mapping of movement to sound as these phenomenon occur simultaneously. 1) Area or space shape for music Key, 2) Movement along XY axis for chord progression combinations and 3) Movement along the Y axis for dynamics. In *Seeing Sound: Hans Jenny and The Cymatic Atlas*, Lewis supports cymatic imaging as a way to “create image based atlases of invisible phenomena like sound” (pg. 4).

John Stuart Reid is the inventor of the CymaScope Pro. His cymatic imaging device and findings grew out of the works of Ernst Chladni, Mary D. Waller & Hans Jenny. In his article “The Physics of Sound” he postulates that sound, although a wave form, travels through molecules in the air and is shaped more like a “bubble”.

J.J. McGowan was able to create a visual representation of Reid's bubble theory in his final project for his Masters degree. Part of his research took him to Sonic Age America, where he played his music through the CymaScope developed by Reid. McGowan painstakingly rendered 3D moving graphics of the sound, complete with particle busts, based on the video and stills of the 2D cymatic images obtained at Sonic Age. The graphics in his final project morphed on screen from shape to shape in time with his musical composition. This was done in post production while editing and presented in video form. I believe it is possible to grow from this and apply 3D cymatic images in a real time, real life environment using 3D projection technology.

### 2- Sonification

In *Conceptual Geometry: Theory and Applications, The distance geometry of music*, researchers attempt to plot music in geometric fashion. While the reading was interesting and informative, it bases it's mathematics on Euclidean Geometry. As I entertain Reid's above “music as a bubble” theory, I am leaning toward Tymoczko's non-euclidean theory, as you will read below.

*The Sonification Handbook*, by Hermann, Hunt and Neuhoff is basically The Bible on this subject. It is also several hundred pages long and I am still digesting this piece.

### 3- Mapping

Upon taking up this research I quickly noticed the name Fredrick Bevilacqua come up attached to several studies including *Virtual dance and music environment using*

*motion capture and 3D motion capture data: motion analysis and mapping music.* His work with his team does not exactly follow my quest for objective mapping but still provides a large body of work that has explored the motion capture piece.

*Physical Movement and Musical Gestures: A Multi-level Mapping Strategy* focuses on the control of a piece that is already in play rather the use of movements to create music. The writers cite Laban and Lawrence's *Effort* theory, which correlates movements to various emotions and dynamics. They utilized this as the basis of three mapping layers applied in their research. While my research leans more toward a mathematical approach to spacial mapping with a focus on the creation of music, a multi layer approach could include the mapping of dynamics. I will be looking at Rudolph Laban's *Movement Analysis*, particularly his "Space Harmony" practice which is supported by similar geometries as the below approach.

Dmitri Tymoczko, a musicologist and mathematician, has published various articles and books. So far his theory using non-euclidean geometry & tonality is a front runner for the mapping of a 3D space to create musical works. The resources I am working through are *General Voice-Leading Spaces* and *The Geometry of Music*. Roger Scruton's *The Space of Music: Review of Dmitri Tymoczko's A Geometry of Music*, looks at "a unified generative grammar of tonal music"(pg 175). He builds a case for a sort of syntax that is present in sound that makes it congruent or bearable, regardless of taste or style preference. In the work he catches the reader up on all of those who paved the way for Tymoczko including Fred Lerdahl and Ray Jackendoff's *A Generative Theory of Tonal Music*. Scruton highlights three of four claims made by Tymoczko: "efficient voice-leading, harmonic consistency and acoustic consonance" (pg. 177) as a support piece of Tonality as Tymoczko's foundation to his model of musical structure as a non- euclidean geometrical architecture and ordering of sound that we define as musical. He also points out the work provides a "computational theory of tonal music [and how it shows how music] might be represented in the nervous system" (pg. 177). This alone gives way to a logical approach to mapping; in that Supervised Learning Algorithms can be compared to neural networks.

#### **4- Technology**

I've worked with various DAW's, VST's, DJ Gear, Lighting, Projection, General engineering interfaces since 1998. (A&R as well as list of programs and gear that I am familiar with is available upon request.)

Currently I am learning JavaScript, Supercollider, Max & am taking a Machine Learning course via the internet. (Kadenze.com, Coursera.com, lynda.com & KahnAcademy.com) A better understanding of this area would be ideal. As it would serve to help me construct and tailor technology.

I've looked into various ways in which others are using gesture control, motion capture, music, midi and more. Resources include: *EyeCon— a motion sensing tool for creating interactive dance, music and video projections, Applications of Motion Capture System: Music, Modeling and Animation, Midi Controller Based on Motion Capture, A look*

*inside Leap Motion the 3D gesture control that's like Kinect on steroids.* Each of these helps to understand the signal flow and possibilities that I can be built upon as I endeavor to map objective parameters as well as dynamics.

## Methodology

A multi layer approach is necessary for mapping and system architecture, I will need to experiment with various configurations of input (movement, voice, motion capture systems and DAWs), programs or algorithms and output for both audio and visual components.

The spacial placement in *Musical Geometry* encompasses nearly every combination of voice leading and key there-in. As a theory, it is useful to envision an objective type of spacial mapping as far as notes and chords are concerned. Due to the limitations of the human body in motion I anticipate the need to create a framework. The focus is to work in concert with movement to create a harmonious outcome, avoiding more dissonant choices. Some of my ideas for this so far include:

- Mapping the space to one key and possibly a relative key for modulation purposes.
- Keeping to a specific song formula. For example- A standard pop formula chord progression could be mapped using I, IV, V, and vi chords as the central area theme to be moved through, ii chord grouped near V & I for any turn around or bridge sections and finally including a II chord on the mapping grid to trigger a key change.

Another schema must be considered to suit the human voice as monophonic instrument. I would like to present a visual of what two to three part harmony looks like cymatically in realtime.

## Possible Outcomes

- Performance or video of several acapella voices stacked with corresponding cymatic images. Possible programs: Ableton Live, VDMX Quartz Composer.
- Art installment: Interactive installment using movement detection to create sound and cymatic images. Possible technologies: Kinect, Leap Motion,
- Composition: Converting midi information from movement, using the mapping framework and motion capture.

For future potential-

- Interactive engine to teach & learn music theory. Possibly a video game scenario that incorporates movement, math, science and music.
- Extra dimensional aspect to music performances for the the hearing impaired fostering a richer and more inclusive environment for diverse audiences.
- Alternative mechanism for Music or Art Composition be it a new VST or DAW. (Native Instruments has released a VST names "Cymatics" but a) it's a misnomer as there is no interaction with cymatic images and 2) it does not incorporate a human-machine movement interaction piece.
- Collection of usable data to observe any patterns between movement and sound before/after volume is introduced to the same choreographed piece.

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