SIMPLETONES

Thesis Document

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Acknowledgements

For my wife Daniela, without whom this journey would not have been possible. Thank you for your love, patience and continuous positive energy.

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Thanks to all the students in my Thesis class. Special thanks to Chris Piuggi, who helped clarify my ideas, and to Liza Stark for her optimism. To all my classmates in the MFADT program.

This was an awesome experience.

Foreword

Classmates testing Trinidad. They are holding lighted controllers to control sound.

My current exploration starts in 2011 Major Studio II with Professor Melanie Crean. One of the main goals in my Statement of Purpose for the MFADT program application was to develop projects integrating education, music and animation, as a response to my different interests and professional background. Before pursuing this thesis I worked as a film director in a production company developing motion-graphic-based projects; I've taught design at various universities, and I've been playing music for more than fifteen years. It made sense to me that these life interests needed to merge into a common project that would both satisfy my artistic curiosity and become something meaningful for others.

With these goals in mind I developed a project called Trinidad, a sound and visual interface that allowed people with no previous musical training to collectively experience sound. The limited time for developing Trinidad strongly influenced my approach. Since for me this was a completely novel subject I operated mostly by intuition. This was extremely positive, it allowed me to explore a virgin territory without prejudice, with complete openness and sometimes, positive ingenuity.

I'm carrying this intuitive approach into my current Thesis, now complemented with a stronger body of research. In many occasions things that by intuition "seemed right" to me were actually already confirmed by someone else, giving each of my steps a theoretical background to rely on.

Abstract

This paper presents SimpleTones, an interactive sound system that enables non-musicians to engage in collaborative acts of music making. The aim of SimpleTones is to make collaborative musical experiences more approachable and accessible for a wide range of users. It seeks to allow active participation in the social aspects of collective musical improvisation, an experience usually confined to trained performers.

SilmpleTones players participate with ease and in real time by operating physical sound controllers in tandem. By using play as a catalyst, the project encourages playful human-to-human interactions through an intuitive interface and a simple set of rules. Setting novices free from the requirement of previous musical experience, they are able to focus on the collaborative aspects of performance, such as synchronizing movements, discovering the system's functionality together and making collective decisions, ultimately engaging a state of group flow.

Keywords

Collaboration, music, play, state of flow, joy, creative engagement, novices.

Faculty

Scott Pobiner, Sarah Butler

I. Introduction

A 35,000 -year- old flute, the oldest instrument known.
source: AFP news agency (Agence France-Presse).

A Jazz trio rehearsal.

1. Concept

Music is among one of the most ancient and ubiquitous human activities. Archaeologists have found that some of the earliest tools created by humans are musical instruments used in ritual gatherings. This supports that historically music has served as a cohesive mechanism for defining communities, for celebration and for mourning. Ancient music rituals were activities where everyone actively participated regardless of their musical expertise (Levitin 2006, 6). In in stark contrast, music making has today become an activity mostly reserved for some people: musicians. For this reason, most people have never experienced the act of making music with someone else. In his book *This is Your Brain on Music*, Daniel J. Levitin explains:

> *Only relatively recently in our own culture, five hundred or so ago, did a distinction arise that cut society in two, forming separate classes of music performers and music listeners. Throughout most of the world and for most of human history, music making was as natural an activity as breathing and walking, and everyone participated. Concert halls, dedicated to the performance of music, arose only in the last several centuries* (Levitin 2006, 6).

I don't consider myself a virtuoso instrumentalist or even a musician. Musical notation is as foreign as Russian language is to me, and I don't really understand musical scales. Yet, I've been making music for more than fifteen years, and I've managed to play in some bands. My sense is that most of musicians don't really care about the technical aspects of music. Musicians make music because they like it, because it is a rewarding and pleasurable activity, and playing with someone else just amplifies those feelings. So I wonder: why is the distinction between performers and listeners so prevalent, especially when making music is one of the things that fundamentally defines us as humans?

Statements like "*I don't know how to play an instrument, therefore I can't make music*" or "*I can't play music with others, I'm not a musician!*" are often-cited reasons why non-musicians feel incapable of participating in collective musical experiences. People seem inherently afraid of playing musical instruments, and much more so when in front of others. The experience of music making becomes something unreachable for most people, something reserved for an elite.

So what role can a Design and Technology thesis play in this issue? How can technology facilitate musical experiences for non-musicians? This thesis proposes that by using play as a catalyst and by providing an interface with a small set of rules, groups of novices can engage in simple, collaborative, sonic experiences, making participants more open to explore music as a group.

As the project to illustrate this thesis, the aim of *SimpleTones* is to provide a structure where participants are encouraged to achieve a loose state of mind and openness towards exploring sound. This state of mind sets the basis for the development of collaborative interactions, in the meantime enhancing the social cohesion between participants and ultimately leading to a state of group flow.

2. Design Questions

- How are novices engaged in collaborative sound experiences?
- How can technology facilitate the musical and social experience?
- How can an interactive system encourage collaboration, while at the same time allowing musical expression?

II. Main Concepts

Young children approach music through playful interactions.
Photo source: Independence Elementary (http://fhsdinde.sharpschool.net/)

My research was primarily focused on the dynamics of engagement as a way to understand how people participate in collaborative, sonic experiences. Four concepts stand out as the pillars where my Thesis is supported: play, flow, entry-level, and social behavior.

1. Play

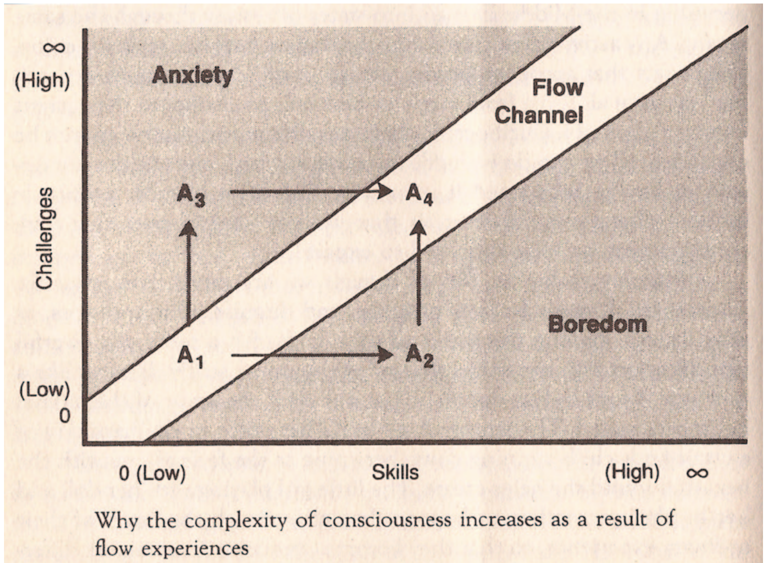
In contrast to adults, young children experience music making on a regular basis. In elementary school for instance, children are encouraged to play instruments and explore music together. By using play as a catalyst, music making becomes something natural and fun to do with others. For children, there is no such distinction between novice and expert, performer or listener. This openness towards musical experiences is in most cases lost as we grow old, becoming the unique purview of musicians.

My thesis proposes that playful interactions are effective mechanisms for facilitating musical experiences for novices. By using play as a catalyst for engagement, participants can feel they are "playing" rather than "performing." Channeling this distinction makes collaborative musical improvisation more approachable for non-musicians.

2. State of Flow

Trained musicians know that making and performing music in collaboration with other players leads to a unique state of mind. No longer focused on themselves, players are focused on the collective action, on each other and on the music. Self-consciousness is reduced and the perception of group-generative synergy is enhanced. When creating music together, there is a rewarding feeling and the act of music making becomes a ritual that enhances the sense of belonging.

Professor and co-director of the Quality of Life Research Center (QLRC) Mihaly Csikszentmihalyi names this as Flow, a mental state of complete energized focus on a certain activity. We experience flow in a variety of activities in our



The Flow channel is a result of a correct balance between challenges and skills.

everyday lives: when we practice a sport, when we solve a math problem or make a sculpture. Interestingly, Csikszentmihalyi notes that music making is one of the activities where flow is easily experienced. In a TED talk, Csikszentmihalyi quotes a musician from one of his interviews:

> *You are in an ecstatic state to such a point that you feel as though you almost don't exist. I have experienced this time and again. My hand seems devoid of myself, and I have nothing to do with what is happening. I just sit there watching it in a state of awe and wonderment. And [the music] just flows out of itself* (Csikszentmihalyi 2004, TED talk).

According to Csikszentmihalyi the dynamics of flow are related to the balance between the challenge that a certain activity imposes, and the skills required to meet those challenges. For instance, an activity becomes boring when the challenges are low in relation to an actor's given skills. In contrast a task leads to anxiety when level of challenge surpasses the set of skills. That's why some people experience flow when playing tennis, while for others the groove rests in cooking (Csikszentmihalyi 1990).

My thesis proposes that by facilitating flow states a sonic experience can become more rewarding and appealing for non-musicians, therefore encouraging musical exploration.

3. Entry Level

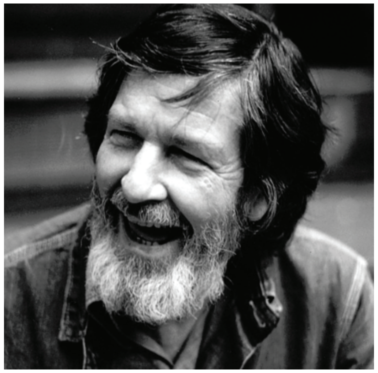
One of the greatest challenges in designing collaborative musical systems is finding the right balance between expressivity and complexity of operation. This balance greatly defines the target audience. Expert performers will need a more expressive instrument because they can deal with the complexities of operation thanks to their musical training. As musician and faculty at Carnegie Mellon University's Entertainment Technology Center Tina Blaine, and University of British Columbia department of Electrical & Computer Engineering Sidney Fels note:

> *... In a collaborative musical environment, it becomes even more imperative that the technology serves primarily as a catalyst for social interaction, rather than as the focus of the experience. Conversely, interfaces that have extended expressive capabilities tend to be more difficult to control and cater more to the expert player.* (Blaine and Fels 2003, 411).

The balance between complexity and expressivity is directly related to the state of flow. According to Csikszentmihalyi, flow states are only reached in an activity when the associated challenges and skills are in balance. When confronted with an extremely complex musical interface, without the skills to master the system, novices would become frustrated, and as a consequence, they wouldn't enjoy the experience.

A. Traditional Instruments

Most traditional instruments require a considerable practice to be mastered. Not knowing how to play an instrument is an often-cited reason why non-musicians feel incapable of participating in collective music experiences. With traditional instruments, materials and physical configuration give each its unique sound: a piano sounds like a piano because it has a large resonant wooden box with two hundred and thirty metal strings inside that can be excited by small hammers when pressing a key that triggers the mechanical reaction. However, the same physical attributes pose a challenge to mastery: a piano can take several years to



John Cage

David Rokeby making a demo of Very Nervous System

Left: Tina Blaine's Jam-O-Drum. Right: Theodore Watson's Vinyl Workout, the speed of a song is controlled by walking in circles around the projected vinyl record.

be mastered, making it unapproachable for novices who are not willing to spend much time practicing.

B. Sound Synthesis and New Musical Interfaces

Since the 1950's there has been an increasing interest in collaborative sound experiences using non-traditional instruments. Examples like John Cage's *Imaginary Landscape Nº4*, where twenty four performers played twelve radios as instruments, have pushed the boundaries of what is considered an ensemble for collective performances (Cage 2012). Since the 1970's computational systems have become more accessible allowing artists and scientists to imagine new ways of interacting with new musical devices and systems.

In the last ten years there has been growing interest within academic and design communities on this subject, proof of which is found in NIME, the annual conference on New Interfaces for Musical Expression. Today, the state of technology and the influence of DIY (Do-it-yourself) culture allows more people to explore new approaches to collaborative musical expression, new forms of musical instruments and systems emerge every time more frequently.

Researchers increasingly "believe that electronically controlled (and this includes computer-controlled) musical instruments need to be emancipated from the keyboard metaphor." In the same article for *Organised Sound*, John Levitin continues: "...although piano-like keyboards are convenient and familiar, they limit the musician's expressiveness (Mathews 1991, Vertegaal and Eaglestone 1996, Paradiso 1997, Levitin and Adams 1998). This is especially true in the domain of computer music, in which timbres can be created that go far beyond the physical constraints of traditional acoustic instruments..."

Known as sound synthesis, this new approach has opened the development of alternative sound control devices and instruments. Projects such as *Very Nervous System* by David Rokeby (1986-1990), *the Jam-O-Drum* (1998), by Blaine and Perkins, and *Vinyl Workout*, by Watson (2006) are just a few examples to emancipate the spectrum of interfaces from the keyboard metaphor.

Since we are no longer constrained by the physical attributes of musical instruments, with thanks in part to sound synthesis we can now start designing simpler musical interfaces to facilitate the musical experience of non-musicians (Miranda and Wanderley 2006, 88). Without the need for musical mastery participants can focus on the collaborative aspects of performance, such as synchronizing movements, discovering the system's functionality together, and making collective decisions, ultimately engaging a state of group flow.

4. Social Aspects

Native Americans gathered around the drum.

To understand the conditions that facilitate engagement, social interactions research implies the necessity of both a behavioral change and the presence of flow. Native American drum rituals for instance, are cohesive social experiences where music acts as an instrument for reinforcing the ties within the community. In these rituals participants sit around a big drum placed in the center. Using a drum stick they hit the drum in a constant and hypnotic pace. The beauty of this ritual relies on the fact that an extremely simple gesture to operate a simple interface is all that is needed to experience flow and make the ritual work, making musical expertise secondary to social experience.

There are certain circumstances that facilitate a change in people's behavior, making them open to a given activity. That behavioral change is profoundly influenced by the nature of the context where the activity takes place. People respond to the special rules that exist only inside that particular space and time. Salen and Zimmermann describe this as the Magic Circle, a parallel space of reality where the world is inhabited only by the participants of the activity:

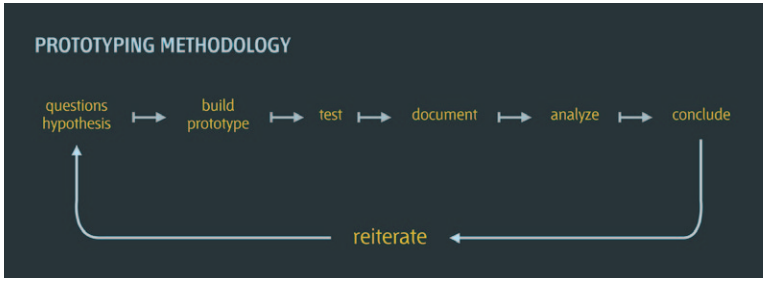
> *...Within the magic circle, special meanings accrue and cluster around objects and behaviors. In effect, a new reality is created, defined by the rules of the game and inhabited by its players* (Salen and Zimmermann 2004, 96).

A Karaoke Bar.

Karaoke bars and booths are good examples of spaces that meet those conditions. Usually used by groups of friends looking for an entertaining experience, in Karaoke bars participants behave in a way completely different from how they do outside. Within this Magic Circle, people are not afraid of singing in front of others and even if they are not good at it, feel no shame about their performance. In a similar fashion, Photo-Booths are also spaces with their own particular rules where people tend to behave differently. It is interesting that although these booths do nothing more than take a set of pictures, there is something unique about entering a very tight box, where people share their personal space with others, and where behaving as children is encouraged.

Photobooths are intimate spaces where people are encouraged to behave differently.

III. Research Process



Methodology scheme: a continuous cycle of prototyping.

1. Methodology

Using a process of continuous iterative prototyping, I performed user tests to answer three main questions: How do people respond to different interface configurations? How do the interface configurations and affordances shape experience? What are the conditions for a system to facilitate flow and joy?

My methodology involved building several prototypes and testing them with users to observe and analyze their reactions. Video documentation was a valuable tool for evaluating these experiences which allowed me to observe in detail how users interacted together, and with the interface. On each iteration different mapping configurations were tested according to progressively increased complexity. Findings from each version were incorporated into subsequent iterations.

Prototype One. Participants making a collaborative rhythm using a MIDI drumpad.

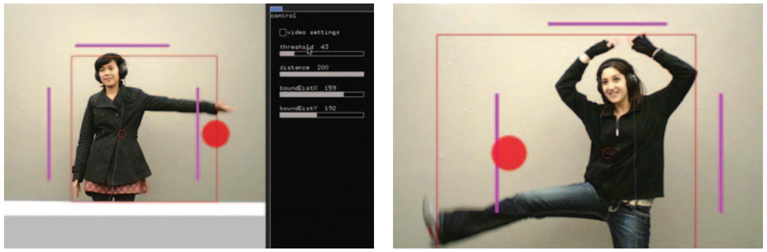
2. Prototypes Overview

A. Prototype One: Collaborative Rhythm

For this early prototype three players were placed around a MIDI device equipped with buttons triggering three different sounds. Each player operated one portion (up to two buttons) of the interface. Participants were instructed to play one sound at a time and only in sequence, after the previous player's turn.

The goal was to collectively create a rhythm where each participant played only one sound at the time. To clarify, this was basically like dividing the role of a drummer among three participants so that the first plays the snare-drum, the second plays the kick-drum and the third, the hi-hat.

The task was simple, but participants had a joyful experience since the goal required high levels of coordination and awareness of the other player's actions.



Prototype Two and Three. Exploring different gestures to control sound.

Prototype Four. A classmate exploring the sound space.

Prototype Four. Computer vision techniques for detecting motion and proximity

B. Prototype Two and Three: Body Gestures

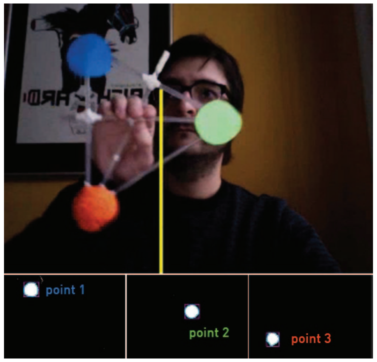
For this second iteration the goal was to observe how participants progressively discover the functionality of a novel interface. Designed for a single participant, users stood in front of a video camera connected to a computer. Sonic feedback was provided using a pair of earphones, visual feedback on the computer's screen where users could see an image of themselves overlaid by the visual interface. A program written in Open Frameworks used camera vision techniques to understand whether the users extended their arms to the right, left or up. Each one of these gestures triggered different sounds the users could hear through earphones, and on the screen a red dot appeared indicating when and which sound was being played.

C. Prototype Four: Sound Installation in Public Space

A sound interface was placed in a highly transited zone where people usually walk by without stopping. The interface was relatively hidden from sight so participants didn't notice its presence until they were close enough. Besides of a pair of speakers and a small video camera, there were no visual cues or feedback indicating the presence of the installation or how it worked.

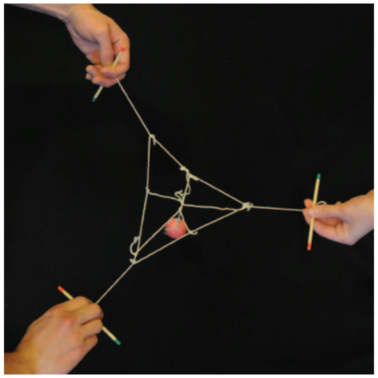
The camera was used to sense the movement and proximity of people who walked by (or entered) the visible space. Based on the amount of movement and proximity, the interface produced different sounds.

Once the users were in the camera's sight a sound became louder or lower depending on how much the users moved. If the participant froze for instance, the sound became inaudible. In contrast if the participant moved, the sound became louder. A second input reading proximity to the camera made a second sound (with different timbre and frequency) becoming louder or lower accordingly.



Prototype Five. Simple Triangle, note the tracking points (below) corresponding to each color dot on the controller.

Prototype Six. Using the same system as Basic Triangle but with a different physical configuration, interaction takes a completely different direction.



A scale model used to define collaborative structures for three participants

D. Prototype Five and Six: Pyramid and Pendulum

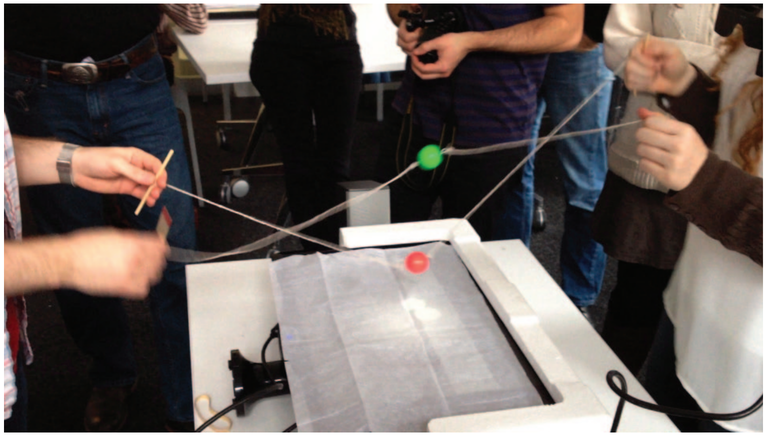
For Prototype Five and Six, I developed two controllers using the same computational system but with different physical configurations. The system consisted of physical controllers that were operated by participants, a USB camera used as a sensor, and a computer vision-based program that read the position of three colored tracking points attached to the controllers. Visual and sonic feedback was provided using a large computer screen and speakers.

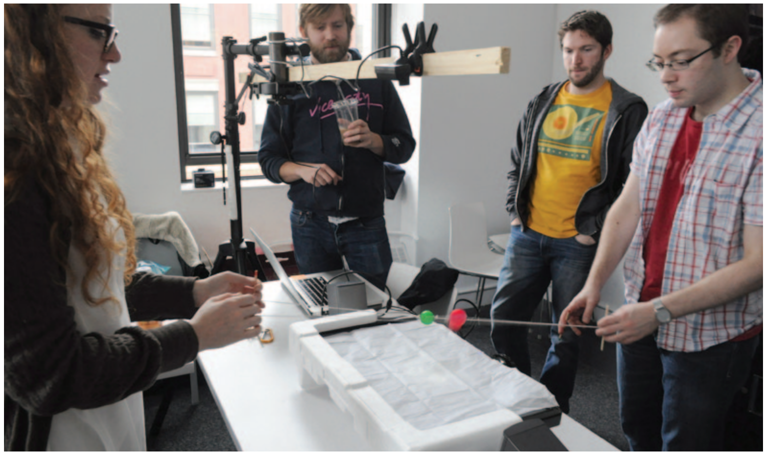
Sound was controlled by mapping the position of the tracking points to different sound parameters. In both controllers tracking points were placed in an inverted triangular configuration. The left and right points controlled the modulation of two different sounds. The amount of modulation was determined by the height of these points respect to the vertical axis of the two-dimensional plane of the screen. A third sound was controlled by the central point. This sound was triggered when the middle point crossed the imaginary boundary drawn in the middle between the right and left points.

Using this structured system, I developed two different controllers. The first, called *Basic Triangle* was a controller operated using one hand. Following the configuration described above, three color tracking points were placed on each of the vertices of a fixed inverted triangle.

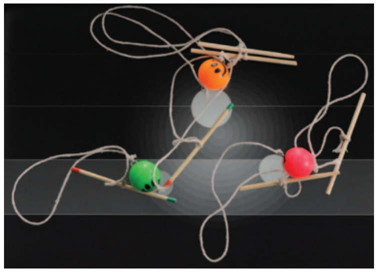
The second controller called *Pendulum*, was a model for use in collaboration between two participants where the triangle created by the tracking points changed its dimensions while in use. It consisted of a weight hanging from a string that connected two rods at their extremes. While maintaining the same computational principles, it created a completely different interaction in comparison to *Basic Triangle*: each one of the participants held one rod with their hand, when moving them up and down alternately in a coordinated pattern, the tension on the string provoked the weight to move as a pendulum. This configuration was deliberatively designed so higher levels of coordination and collaboration between participants were required to achieve the desired rhythmic pendular movement.

This set of two prototypes became a cornerstone in my research. I could see how using physical artifacts, the interaction became much more appealing for





Prototype Seven B. Tabletop interface and collaborative controllers in use.



The controllers.
In the background, the graphical user interface on a computer screen.

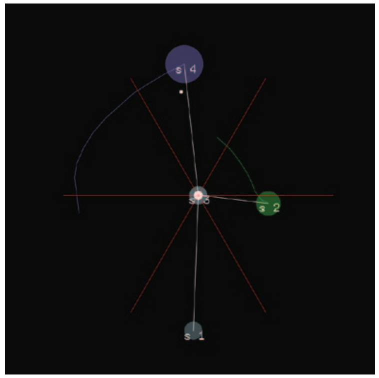
participants. In addition, the physical affordances of objects became a new variable of interaction. Attributes such as size, weight and materials could now play an active role in how the users approach the interface.

E. Prototype Seven A and B: Tabletop Interface

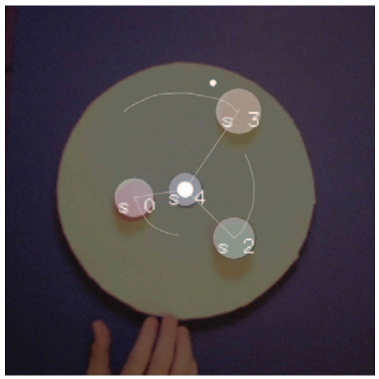
For this stage I developed two prototypes for two players using a tabletop configuration with a camera placed on a top view. The tangible controllers consisted on Super Balls connected with strings to two little sticks on each end, so participants could hold each one of the strings from their extremes while having the Super Ball in the middle, in a similar fashion as the *Pendulum* prototype. A camera was placed over a table where all the interaction took place. Versions A and B differed on the placement of visual feedback. While version A was using a screen placed on one side of the participants, on version B a computer screen was placed facing up on top of the table, allowing the visual focus for controllers and user interface be on the same spot.

The collaborative conditions of the physical controllers required both participants to coordinate their movements and be facing each other. Although the experience was successful in terms of entry level (it was very easy to operate) and the collaborative aspects were very evident, I was not entirely convinced about this solution. The mood was mostly introspective, and participants seemed to be very focused on the interface's functionality and coordinating the movements with their partners. Having the visual feedback in the center and the aesthetic quality of sound may have influenced to provoke this mood.

In overall, the interaction resulted less explorative and loose than the previous prototypes, making the expressive potential be reduced and consequently the novelty within the experience last less time.



*Prototype Eight.
Graphical user interface.*



A scale model to design the computational measurements. The white circle is a turnable plate simulating participants moving around the center point.

Classmates testing the first version of SimpleTones.

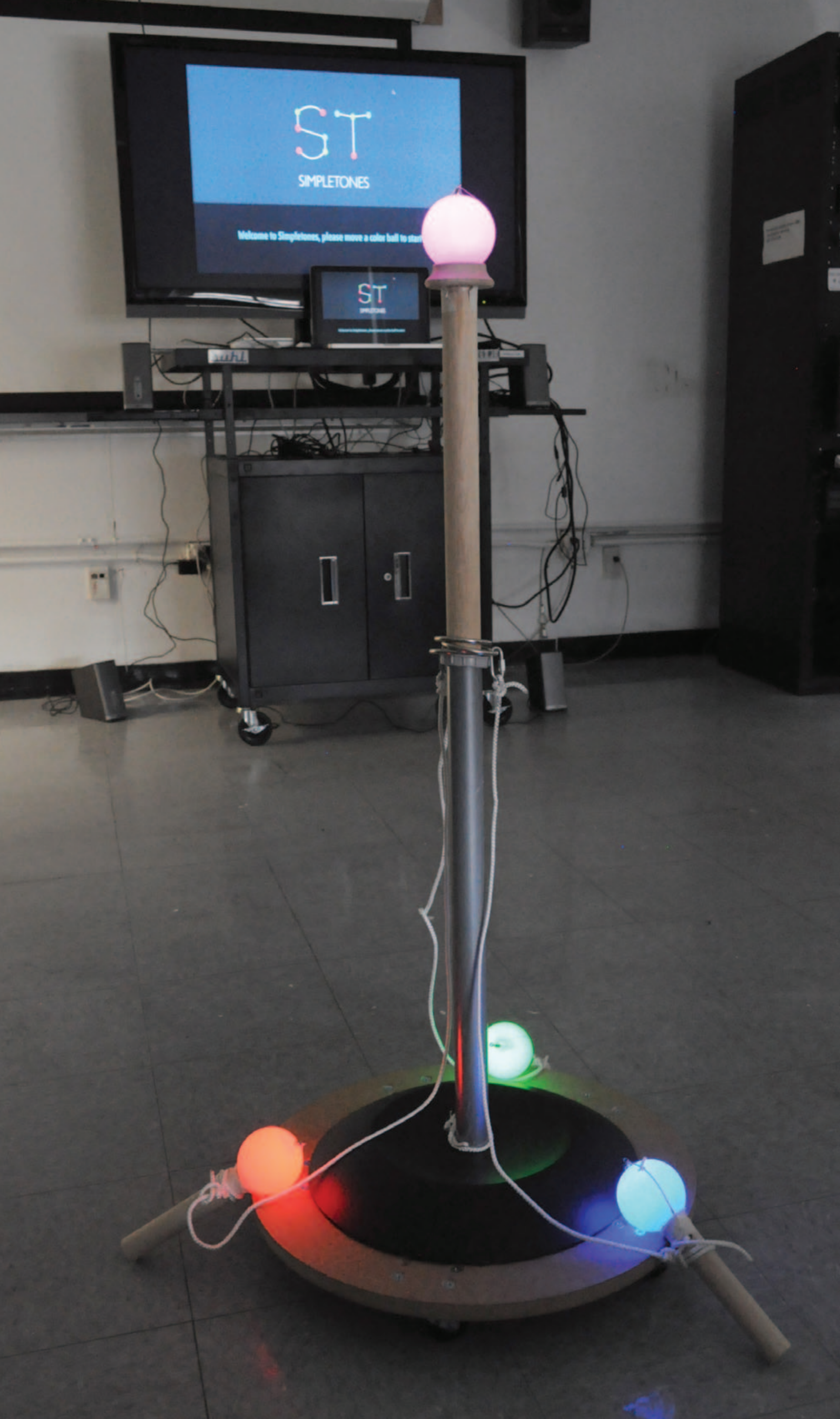
F. Prototype Eight : SimpleTones Version One

Prototype Eight is a milestone in the development of the project, it is the first prototype that I consider a rough version of *SimpleTones*. Although designed for three players, it could be easily scaled up to allow more players using the same computational system.

Participants use hand-held controllers with an attached colored-tracking point. Each one of these controllers is connected to a central structure by a rope. The central structure (The Pole) has wheels, so it can be moved around the room where the main interaction takes place.

As opposed to the previous prototypes, this configuration actively integrates the use of the space that surrounds the interface, making the space become part of the interface.

The user testing was very successful. Participants were engaged in the experience, and most importantly, the expected behaviors such as communicating and sharing discoveries took place in several moments. The active physical interactions that the interface encourages (such as running in circles around the pole) made the experience more joyful. This configuration allows more freedom for exploring the common interaction (i.e. moving the pole to a different place in the room) as well as the personal interaction space (with the hand-held controllers), making the expressive possibilities larger. All these variables influenced on the time of obsolescence of the experience that was increased enormously compared to previous prototypes that made use of more passive physical interaction.



IV. SimpleTones

1. Project Abstract

SimpleTones is an interactive sound installation that enables non-musicians to engage in collaborative acts of music making. Players can participate with ease by operating physical sound controllers in tandem. By encouraging playful human-to-human interactions through an intuitive interface and a simple set of rules, *SimpleTones* sets participants free from the requirement of previous musical experience, allowing them to focus on exploring the sound space with other players.

Inspired by the traditional ritual of the May Pole, the interface consists of three hand-held color-lighted objects connected with ropes to a central structure (a pole with wheels). Sound is triggered by moving the controllers around the pole. *SimpleTones* encourages active physical interaction, such as running in circles or moving the pole around the room to discover hidden sounds.

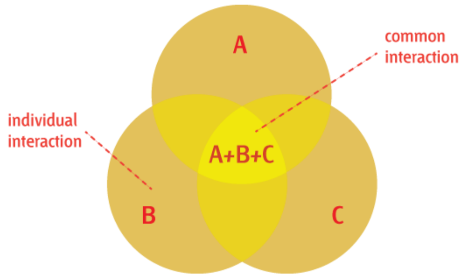
By using play as a catalyst *SimpleTones* makes collaborative musical improvisation more approachable for non-musicians. Without the need for musical mastery, participants focus on the collaborative aspects of performance such as synchronizing movements; discovering the system's functionality together, and making collective decisions, ultimately engaging in a joyful state around music improvisation, an experience usually confined to trained performers.

2. Design Questions

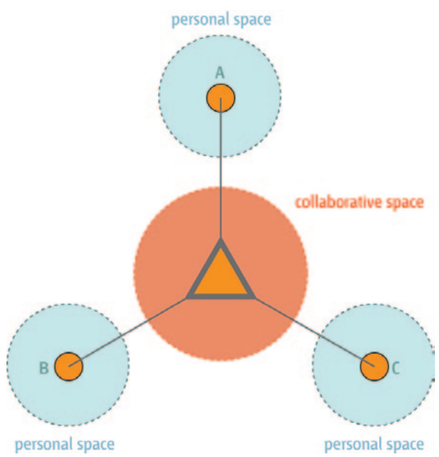
- How are novices engaged in collaborative sound experiences?
- How can interface rules and functionality become intuitive without the need of explicit directions?
- How can a structured system facilitate engagement and foster collaborative musical expression?

3. Goals

- Use technology to facilitate musical experiences for non-musicians, encouraging communication, collaboration and creative engagement with sound.
- Provide a space where, without the need of previous musical training, non-musicians can collaboratively explore, improvise, and enjoy sound in a fashion similar to how trained musicians do.
- Create a structural system that, maintaining the same basic principles, allows scaling to different number of participants.
- Create a system that encourages personal and collective exploration of sound.
- Provide an interface with a small set of rules to encourage emergent play.



Venn Diagram of social model.



Individual and common spaces of interaction.

One of the main challenges when designing a collaborative musical interface is to balance the expressivity and complexity levels.

4. Interaction

A. Concept and Social Model

The project relies on a conceptual model whereby participant can explore together both individual and collective spaces of interaction with sound. This coexistence is reflected in the interface design which in its physical affordances requires collaborative operation, but also allows independent interaction.

B. Entry Level

SimpleTones addresses the entry-level challenge by relieving participants from the responsibility and expectation of creating harmonic compositions. This is done by reducing the amount of possible notes that can be played. By carefully selecting a particular scale or chord, harmonic compositions can be created regardless of the performer's musical expertise. Having a small range of notes makes the system less expressive to the eyes of an expert, but is a necessary trade-off to facilitate a rewarding experience for novices.

Although *SimpleTones* is geared mostly for novice experiment, by presenting itself as a musical experience rather than a musical instrument, I believe there is space for trained musicians. Making clear that *SimpleTones* is not for expert performance, it relieves trained musicians from the frustration of being confronted by (or confined to) a restrictive instrument. The novel shape and mapping of the interface helps to maintain an adequate level of curiosity. Following iterative research conducted throughout my thesis program I believe novices and experts can share the experience provided by *SimpleTones* because the goal is more precisely social interaction, than expert musical expression.

The May Pole ritual

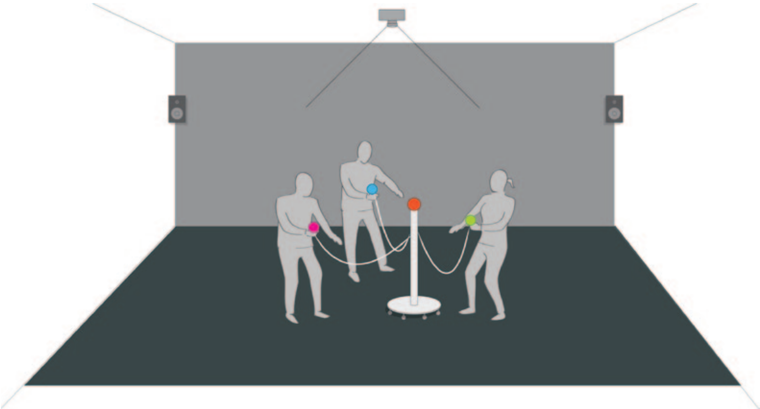
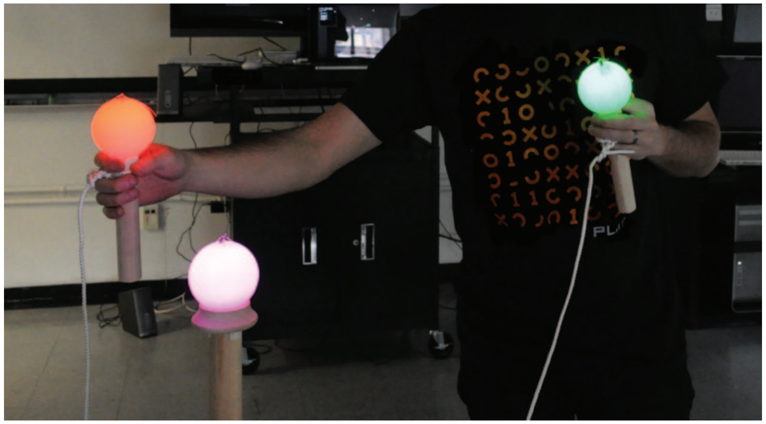


Diagram showing the installation setup.



The hand-held color-lighted controllers.

5. Interface

A. Physical Structure and Interaction

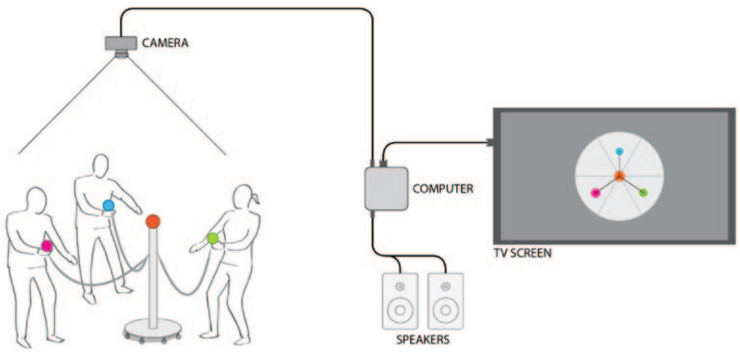
The physical configuration of *SimpleTones* takes inspiration from the May Pole, a ritual that takes place in many countries to celebrate the return of summer. The May Pole ritual consists in a group of dancers that gather in a circle around a pole. Each participant holds a colored ribbon attached to a smaller pole. By dancing in circles around the center, and by maintaining a constant choreography, ribbons are intertwined on to the pole resulting in a beautiful, collaboratively woven pattern of colors.

Similarly, *SimpleTones* uses three tangible hand-held controllers operated by three participants. Each controller is connected by ropes to a central structure (a pole with wheels), that can be collaboratively moved around the space by pulling the ropes or by pushing it directly by hand. To move the pole participants need to somehow communicate and coordinate their movements. Collaborative decisions are requisite since they are all connected to the same structure. For example, to go from one side of the room to the other, they need to coordinate movement in tandem.

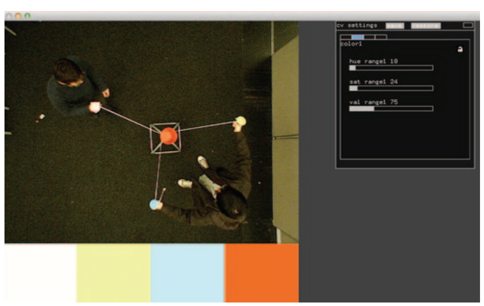
B. Scalability

This version of *SimpleTones* is designed for three participants. This number is an adequate scale because it allows participants to understand their own contribution to the sound composition without producing musical chaos. However, using the same principles and computational system, *SimpleTones* could easily allow a larger (or smaller) number of participants. This would require adjustments only to sound output making explicit who is playing each sound (as more the number of participants, the harder is to identify one sound from each other) Based on space allocations for exhibition of *SimpleTones*, I decided to cap the maximum number of participants, thus maintaining a harmonic sound output regardless of how users interact with the system.

Users exploring the latest version of SimpleTones.



Installation technology setup.



GUI of the system. On the top-left corner, a snapshot taken from the camera on the ceiling

C. Space

The aim of *SimpleTones* is to encourage active physical interaction. For this reason space plays an active role within the interaction and is considered a part of the interface. Participants can interact with the space by moving the central pole to different positions in the room, encouraging at the same time, an active use of the surrounding space and the use of whole body interaction.

D. Computational System

The computational system includes:

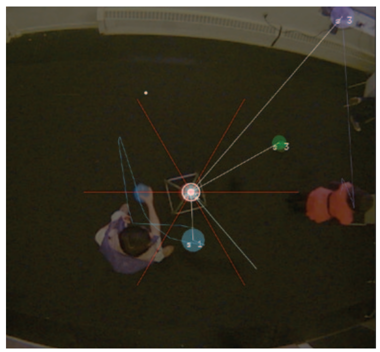
- A videocamera used as a sensor
- An Open Frameworks software that processes information gathered from the camera and outputs OSC (Open Sound Control) messages
- A software that converts OSC messages into MIDI messages
- A music software (Ableton Live) that receives MIDI messages to control and produce sound
- A TV screen for visual feedback
- Speakers for sonic feedback

Computer Vision

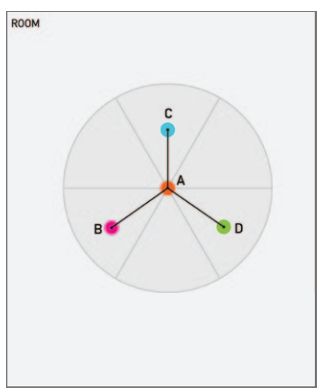
The gestural capture strategy is based on tracking the position and movement of a series of tracking points attached to the handles of the controllers. Tracking a point means to constantly read its relative position in a coordinate system of a two-dimensional plane (the screen).

The selected technique to perform this task is color tracking, effective for identifying each point and distinguishing it from the rest. However, color tracking supposes a special set of challenges when dealing with a system for a public installation. Since the system identifies specific colors all colors in the camera's view are considered. This includes the participant's clothing, or the colors on the background. For the system, there is no difference between a red shirt and a red controller.

Participants collaboratively exploring the interface and sound space using lighted controllers as tracking points.



A screen capture from the camera on the ceiling. Note the misplaced purple dot on the upper right corner indicating that the system gets confused under certain light conditions



A diagram showing the central point A (pole) and the three hand-held controllers B,C,D.

In order to work accurately regardless of consequential colors, the program uses lighted tracking points and controlled light conditions for the space (dim lights). This way the tracking system filters incidental colors by their brightness threshold. In relative darkness, clothing and background will be seen as almost black, but the lights will be clearly contrasted to the background, becoming then reliable tracking features.

The use of lighted controllers also responds to aesthetic and context requirements. Having low light conditions will create a more intimate atmosphere, helping participants be more open towards behavioral change.

Mapping

The mapping system is largely based on the *Basic Triangle* and *Pendulum*'s system where the position of points is used to control different sound parameters. Consequently, when controllers are moved in space they modify different sounds.

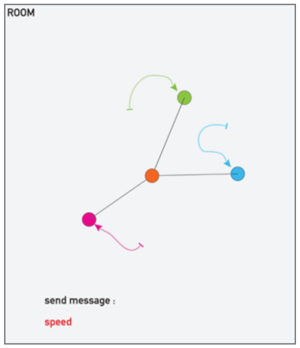
Four points control the main interaction. One central point attached to the pole (point A) and three points attached to the hand-held controllers (points B, C, and D).

Reflecting the physical configuration of the physical structure, the central point becomes the center of a circumference, where the maximum radius is determined by the length of the ropes. Points B, C, D can move freely around the center point.

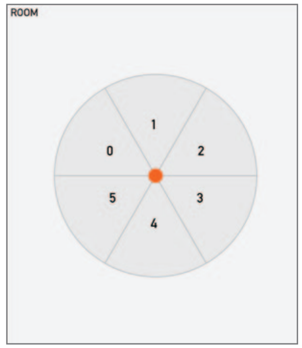
One additional point (R1) used to control a rhythm loop is placed in a specific location of the room.

There are three main variables used to control sound:

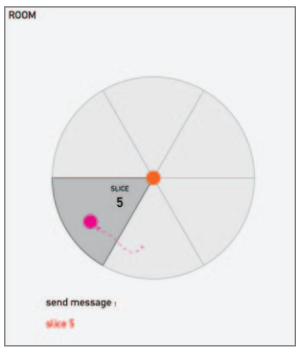
Speed: a first set of sounds is controlled by the speed in which the participants move the controllers. If they move them quickly for instance, the sound gets louder, and when moved slowly, the sound becomes inaudible.
Angles: basically this measurement consists in calculating the angle formed between the center point A to each one of the control points. The virtual



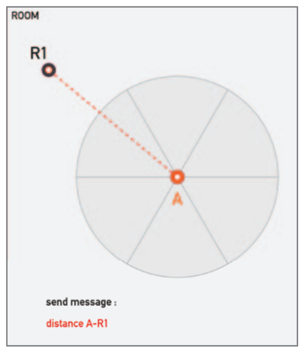
Measuring speed.



When a points enters a slice it triggers a note.



With the pole in the center, the the circle around it is divided into sections (as pizza slices).



Measuring distance to a specific point in the room.

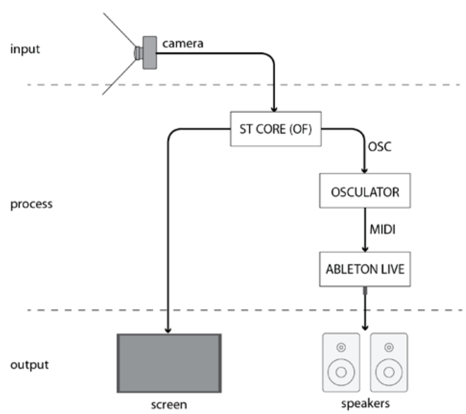


Diagram showing how the data flows through the system

circumference created around the central point A is divided into sections (similar to pizza slices). As the tracking points enter these sections, they trigger different tones of a chromatic scale. This can be compared to pressing the keys of a piano, but where the keys are displaced around the center of a circle.

General position: this is the relative coordinate position of the central point A in the visible area of the video camera (thus, to the room). The distance between the center point A and point R1 determine the volume and/or tempo of a corresponding rhythm. The rhythm is a pre-composed loop that is constantly playing. If the participants move the pole closer to this point, the corresponding rhythm will get louder and faster. This encourages participants to explore the whole room, and at the same time, provides the choice of having a background rhythm if wanted.

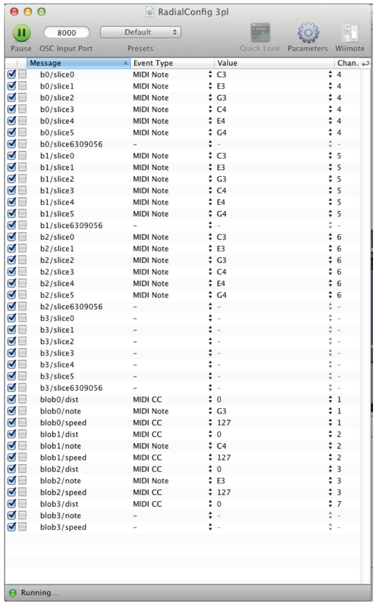
Data Flow

The computational system follows a logic of sending messages between different softwares chained together to produce and control sound. The data flows through the chain using a networking protocol called UDP (User Datagram Protocol).

The chain is composed by three softwares: a C++ program built in Open Frameworks, an OSC-to-MIDI translator, and a music generator software.

The custom C++ program, that will be called *STCore* was built using Open Frameworks. *STCore* is the "brain" of the system. It performs all the computer vision tasks, such as managing the camera, tracking the light points, determining the points' positions, etc. It also translates the coordinate positions of the points into messages in the OSC (Open Sound Control) format. OSC is a content format used to send messages between devices and/or between software, in a similar fashion as the MIDI messages do.

STCore sends these messages to a second software called Osculator, a program that can receive OSC messages and translate them into the MIDI (Musical Instrument Digital Interface) protocol. Osculator sends the data, now as MIDI to a third program, Ableton Live, a music production and performance software is in charge of producing sound. It was chosen because its ability to produce



The Osculator Patch. It receives OSC messages from Open Frameworks and translates them into MIDI messages.

The Ableton Live file. Here is where all sounds are produced.

high quality sounds that can be controlled via MIDI.

Sound

Throughout the prototypes I could see that the aesthetic quality of sounds was fundamental aspect for shaping the experiences. Percussive sounds create a different atmosphere than soothing sounds, thus, becoming a strong influence to the general mood of the experience.

Paying special attention to musical harmony *SimpleTones* uses a chromatic scale of C-E-G, notes that together conform a C Major chord. By limiting the possible notes to a few, the overall sound output remains harmonic no matter what notes are played or in what order.

In Ableton Live, each sound resides in a different sound track. Sound parameters such as volume, filters, or triggering virtual instruments are controlled by the *STCore* program.

The rhythmic loop (associated to a specific points in the room) is also embedded in an individual sound track. Its volume is increased or decreased depending on the proximity of the central point (the pole) to the associated point.

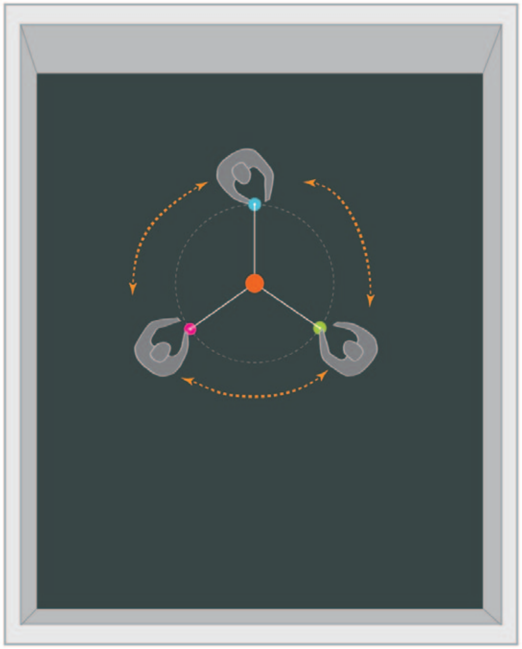


Diagram showing the interaction in the space as seen by the camera.

Installation of SimpleTones at D12 lab (Parsons building in NY)

E. Installation

My quest when developing the system was to create a flexible and easily mutable configuration that could allow, for instance, relatively simple changes to sound aesthetic, or number of participants That said, this configuration of *SimpleTones* was designed specifically for the Parsons MFADT program Thesis Exhibition.

For this exhibition, *SimpleTones* is setup in a room equipped with a TV Screen and four speakers. The area in use is around 320 square feet (around 30 square meters), corresponding to a room approximately 18 by 18 ft. (5.5 by 5.5 mts.). This is an adequate space to allow the participants move in circles around the pole and to translate the pole to different zones of the space.

V. Conclusions and Next Steps

Kids testing the final version of SimpleTones.

1. Findings

SimpleTones is hard to classify. It is neither an instrument nor a game, although it has elements of both. This is one of the strengths of the project, in that by presenting itself as something different from an instrument, non-musicians perceive the interface as more approachable. The project does not imply the culturally coded distinctions of "playing it right or wrong". Play becomes then an effective tool for making musical experiences more engaging for non-musicians, ultimately allowing the focus to shift from musical skill to social interactions.

In all the tests performed with earlier and more advanced prototypes, participants found the experience enjoyable regardless of the complexity of the interface. This indicates that interacting with musical interfaces that gives the participants space for expression and creativity is a rewarding experience for most people.

On the latter tests performed with *SimpleTones*, a wide range of interactions could be observed: from participants running around the pole to participants slowly waving the controller up and down. This supports that the range of possible interactions was adequate to maintain engagement with the system. By allowing a low-level entry and providing a broad range of possibilities, the experience can be sustained for longer periods of time.

SimpleTones can enhance social bonds, or create new ones. In groups of participants that already had close relationships (i.e friends or family) the time to achieve a group state of flow was reduced, making the overall experience quickly enjoyable. In the latest tests, participants had the chance to use the interface with strangers. Here, it could be observed that in a short time frame, even odd groups were able to engage in the collective experience. Supporting that *SimpleTones* provides a fertile ground for social bonding,

The prototyping process was a continuous exploration to understand the necessary conditions of engagement with collaborative sound systems. It also served to make clear how the physical affordances of the interface can shape the experiences in so many different ways. Configurations that allow the use of the whole body encourage a more active physical interaction. In contrast, configurations that require a smaller range in movement will encourage more introspective states of flow. This suggests that the mood of the experience (i.e.aroused versus relaxed) is in some degree determined by the level of physicality that the interface affords.

The learning process of a collaborative system is largely based on imitation. One of the most interesting observations from the tests is that participants, when collaboratively engaged in learning a new system, tend to mimic each other. Beyond verbal communication, participants were able to use body language to transmit consciously or unconsciously their findings to the rest. For instance, if someone discovered that by moving the controller in a certain way produced a particular sound, most of the times the rest of participants would try the same action after seeing the results. In that sense, *SimpleTones* acts as a playground for communicational experiences.

As a metaphor for the dynamics present in an expert ensemble environment, *SimpleTones* illustrates the basic principles of any collaborative experience around music: becoming aware of the other's actions, setting the mind free and open to creative engagement, discovering functionalities together, learning and sharing information and taking collective decisions.

2. Future Steps

I consider that this process is an ongoing journey, there are great challenges for the future of this Thesis and project. At this point I'm able to visualize specific enhancements that would make the interface better and more suitable for a more permanent public installation:

- Enhancing the interface to be more intuitive, thus reducing the need of visual feedback. This would require for example, embedding the visual feedback into the physical controllers or incorporating haptic feedback on the controllers.
- Making the system smarter by implementing learning algorithms. By doing this, the system could dynamically adjust itself to fit broader ranges of expertise, most likely by defining different levels (as in a game). Learning algorithms could also help to determine when visual feedback is no longer needed once participants understand how the system works, leaving a greater space for human-to-human communication.
- Designing a more sustainable interface. In the future, *SimpleTones* might need a better way of dealing with power. Naturally, there is energy consumption from the light controllers that is currently provided by disposable batteries. A better configuration would include rechargeable controllers, that when not in use, could be left in their charging docks.

3. Future Scenarios

In Physical Therapy: the affordances of the interface encourages certain specific physical interactions. In *Pendulum* for instance, the main physical interaction involved moving the arms back and forth. In *SimpleTones*, participants tended to run in circles. For Physical Therapy, *SimpleTones* could be reconfigured to encourage a specific kind of movement. Physical Therapy tends to be tedious and sometimes repetitive for patients. Here is where *SimpleTones* could play a role in making exercises routines more appealing, thus facilitating engagement with therapy.

In Music Education: an abstract system like *SimpleTones* could be a powerful educational tool for novice musicians. There is potential for instance, to learn how to synchronize with someone else by encouraging improvisation.

4. Adiós

This process has been intense and very exciting. What I learned from it will remain always with me, and my plan is to take this initial research (which is just the tip of the iceberg) to new and higher levels in the future.

Thanks for reading.

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Annotated Bibliography

Blaine, Tina, and Sidney Fels. 2003. Collaborative musical experiences for novices. Journal of New Music Research 32 (4) (12): 411-28.

This paper makes an extensive analysis on the design of interactive systems for collaborative musical interactions involving novice players. Finding the common components that give shape to the different projects, the authors create a methodology of analysis that can be applied to any project working in this realm. One of the main points of the text that is most relevant for my thesis, relies on the idea that creating an engaging social experience is the primary goal, putting musical as secondary goal. It also brings an insightful way of dissecting these projects into constitutive parts, creating a framework that to certain extent is applied to my own project.

Csikszentmihalyi, Mihaly. Flow: The Psychology of Optimal Experience. New York: Harper & Row, 1990.

The author describes from a psychological perspective the dynamics of flow, the mental state of complete focus on a certain activity. Although part of our everyday's life, the state of flow is achieved under certain circumstances that deal with the balance between the skills and challenges that the activity poses. My interest on the author's theory is that one of the domains known for facilitating flow is music.

Salen, Katie and Zimmerman, Eric. Rules of play: Game Design Fundamentals. London: The MIT Press, 2004.

This book is an extensive study around the activity of play. Analyzing the dynamics that allow its generation, it becomes an enlightening tool not only applicable to game design, but for any system that involves play. It becomes then a framework for many of the ideas that shape the collaborative experiences addressed in the thesis I'm developing.

Blaine, T. and Perkis, T. The Jam-O-Drum Interactive Music System: A Study in Interaction Design. In Proceedings of Symposium on Designing Interactive Systems. 2000, 165-173.

This paper is a detailed explanation of the process and methodology for designing the Jam-O-Drum, a collaborative interactive system based on a table with four drum pads and a projected image on the surface. The Jam-O-Drum project shares a lot of common goals with my own. One of the most valuable aspects of this paper is the detailed explanation of the design methodologies used on the development stage, how they tested different alternatives isolating each one of the parameters and testing them separately in an iterative approach.

Levitin, Daniel. This is your brain on music: the science of human obsession. New York N.Y.: Dutton, 2006

In a beautifully written book, the neuroscientist Daniel J. Levitin explains for a general audience how our brain and mind work when exposed to music. From a scientific approach as well as from a personal view–he is a music performer and producer–Levitin dissects how music is perceived, how it affects our societies and our life in general. My interest on this reading is the insightful explanation of what happens inside of us around music, particularly interesting is how he describes the dynamics of perception when creating music.

Miranda, Eduardo R. and Wanderley, Marcelo M. New Digital Musical Instruments: Control and Interaction Beyond the Keyboard. Wisconsin: A-R Editions, 2006.

This book presents a detailed and vast analysis of different projects developed with the aim of creating new kinds of instruments making use of new technologies. It presents a wide range of different approaches to the design of DMI's that try to expand the boundaries of what we commonly define as a musical instrument. Although I think it lacks of a deeper examination of the conceptual background around the study, it presents an extremely useful explanation of the different variables involved in the design of DMI's through numerous cases of study. Particularly useful is the section where collaborative instrument approaches is presented.

Glossary

Flow (state of)
Term coined by the psychologist Mihaly Csikszentmihalyi regarding the mental state of complete energized focus in a certain activity.

Expert
Person who has either formal or informal musical training.

OSC
OSC stands for Open Sound Control, a content format for sending messages over a network. It is usually used as an alternative for the MIDI standard or sometimes as a complement for it.

UDP
Stands for User Datagram Protocol, UDP is a protocol for sending messages between applications over a computer network.

Open frameworks
A code-based framework based on C++. It is a collection of libraries that makes programming in C++ environment more accessible for artists and creative coders.

Ableton Live
A software for creating, recording, mastering, and Dj'ing music, presented as an intuitive interface. This software is capable of receiving and routing MIDI messages in a simple way, so it easily allows connecting it to external MIDI controllers or to other pieces of software.

Computer Vision
Technique that uses video cameras to capture and analyze images from the real world and translate them into numerical data, allowing to understand, for instance, the coordinate position of a given point in space over time.

Novice
Person without formal or informal experience in musical performance.

Harmonic
Harmony

Loose state of mind
A mental state that allows openness to new experiences.

Base
Refers to the dimension of music that is usually performed by the bass.

Melody
Refers to the most recognizable part of music, usually performed by the main voice, guitar, or piano.

Ambient sounds
Usually referring to sounds that create a calm atmosphere.

Collective sound experience
Group activity that involves music performance.

Scale
Number of participants that an interactive experience allows.

Controller
Device that controls sound parameters.

Rhythm
Sound organized in repetitive intervals.

Timbre
The unique quality of sound that makes two instruments playing the same note to sound differently.