Using digital technology to enable new forms of audience participation during rock music performances

by

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Abstract

Technology has long been used to improve the presentational aspects of a live music performance, but less often is it employed to encourage participation from audience members. This thesis investigates how digital technologies might be used to make traditional pop and rock concerts more participatory. An ethnographic study was first carried out, surveying concertgoers and conducting interviews with experienced musicians to identify current attitudes towards audience participation and technology-enabled events. Prototypes were developed and tested to investigate new methods for facilitating audience involvement during a performance. The final prototype was developed in collaboration with a local band and tested with twelve audience members during a twenty-minute performance. The users and performers found the experience satisfying but also indicated that the novelty of the interaction may not last through full-length performances. It was concluded that digital technology provides new opportunities for audiences to participate in music performances. Future iterations will aim to include a larger number of users, and it will be investigated how the system can be made dynamic to allow for multiple modes of participation throughout a single performance.

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Chapter 1

Introduction

At the 2011 Coachella Valley Music and Arts Festival, Monteal-based indie rock group Arcade Fire are about to play one of the final songs of their headlining set. The guitar riff from the band's hit song "Wake Up" is instantly recognized by the audience, who cheer loudly with excitement. The song reaches the first chorus, and, suddenly, one thousand white beach balls begin tumbling over the top of the stage and gently fall onto the crowd below. The cheers swell into a roar as the balls disperse over the mass of people. When the band hits the song's final chorus, to the audience's surprise, the balls begin to light up – flashing different colours to the beat of the music. Arcade Fire finish their set, grins on the band members' faces, as they watch the glowing orbs bounce across the crowd. After the show, festivalgoers hold on to the beach balls; vehicles leaving the festival grounds are seen glowing with the light from what have now become souvenirs from an unforgettable live music experience.

This project was made possible by several teams that managed the logistics, developed the wireless LED devices, fabricated and tested hundreds of beach balls, and ultimately executed the launch[1]. The result was an awe-inspiring, albeit momentary, event that allowed the audience to participate in the performance. Rock concerts seem to be growing more technically complex and spectacular all the time. Powerful equipment makes shows louder,

[1] `http://www.momentfactory.com/en/project/stage/Arcade_Fire`

larger, and flashier. Only recently, however, have artists and researchers begun investigating how technology can amplify not just the performer's actions, but those of the audience members as well. This thesis examines these sorts of technologies, asking how they might be used to make conventional rock concerts more participatory.

1.1 Motivation

In his 2008 book *Music As Social Life*, musicologist and anthropologist Thomas Turino divides live music performances into two categories – presentational and participatory. In presentational performances, the artist prepares music and presents it to a separate group, the audience. An example of a presentational performance would be a typical rock concert; a band rehearses and plans a set list and then performs it for a generally attentive audience. Participatory performances, on the other hand, deal only with participants and potential participants, and there is no artist-audience distinction. Peruvian communities, for example, perform in large groups with each participant either dancing or playing a panpipe or flute.

Researchers have found evidence of musical activity from every known era of humanity (Levitin, 2006). While music has served various function for different cultures – used to remove curses (Turner, 2011) or even to settle lawsuits (Jourdain, 1997) – it is most widely regarded as a relationship-forming social activity (Levitin, 2006; Turner, 2011). It is only in the last few centuries that presentational performances have become ordinary public events. These grew in popularity when entrepreneurial musicians began taking advantage of the emerging middle class, members of which were eager to display their newfound wealth (Small, 1998). Eventually, art music (now typically referred to as classical music) performances established a strict divide between performer and audience; musicians dressed alike and performed composed and rehearsed pieces while audience members sat silently and attentively.

While today's popular music concerts are more relaxed, the divide between performer and audience is still prominent. Furthermore, performances today are more presentational than ever, with all sorts of additional stimulus being blasted at audiences. Giant screens display complex visuals and extreme closeups of performers, and heavy-duty mechatronics are incorporated to dynamically change the shape of the stage. Auslander (1999) suggests that this focus on the visual is a response to the visual culture established by mass media – namely, MTV. Many concertgoers could be satisfied by an entirely lip-synced performance if it is enough of a spectacle for the eyes.

Despite this focus on the presentational, audience involvement has managed to survive as a minor participatory element in rock concerts. Audience members become a part of the performance by singing or clapping along, holding their illuminated lighters or cellphones above their heads, or simply moving to the music. Some musicians take song requests, and some even invite audience members on stage to dance alongside them. In rock music, the barrier between the audience and the performer is frequently crossed.

Just as concerts became more visual in response to an increasingly visual culture, I believe that they are now becoming more participatory in response to an emerging "participatory culture" (Wikström, 2013). The unprecedented connectivity afforded by the Internet and digital technologies is bringing artists and their followers closer than ever. Musicians can talk to fans directly on social media websites and receive instant feedback on their work. Fans can remix their favourite artists' songs or create their own music videos to accompany them. Social networks form around concerts as attendees connect with each other beforehand and artists curate fan-shot images and video online afterwards. Rather than flowing from performer to audience, information now freely flows between the two parties.

By taking advantage of this participatory culture and the technology that produced it, we might begin seeing more performances in which music can better function as the communal activity it has always been.

1.2 Research Question

How might rock performances be made more participatory using digital technology? This question leads to many others. For instance, how – if at all – do modern audiences want to be involved in performances, and how much control do today's rock musicians feel comfortable giving up? What aspect of the performance can be reasonably controlled by a large number of people? How can inputs from each audience member be captured and processed? And when such a system is implemented, does it actually improve the concert experience for both the audience and performer?

These questions are not only relevant culturally, as illustrated in the previous section, but technologically as well. The ubiquity of public displays, connected personal devices, and movement sensing technology means crowd-based interactions are becoming increasingly practical (Brown et al., 2009). Indeed, human-computer interaction (HCI) researchers are only recently beginning to investigating how systems might be designed for a large assembly of users. In addition to investigating crowd-based interfaces (Maynes-Aminzade et al., 2002; Feldmeier & Paradiso, 2007), researchers have been asking how these systems should be implemented when a performer is introduced (Gates et al., 2006; Barkuus & Jørgensen, 2008). This work has only looked at dance performances, rap competitions, and nightclubs, however; there is insufficient research on incorporating these systems into rock performances.

Despite the lack of research, many inquisitive rock musicians are already showing interest in participatory technologies. Groups like Coldplay[2] and Kasabian[3] have experimented in recent years with new ways to involve audiences in their performances. These technologies have been appearing at large outdoor music festivals and incorporated into performances streamed online where anyone with an internet connection can get involved.

Lastly, it should be noted that the live music industry is growing rapidly (Wikström, 2013). The digital revolution caused record sales to plummet, whereas live music revenues are larger than ever. While touring used to be a method for promoting recorded music, the opposite is now true. Wikström speculates that "live music will soon dominate the entire music industry in the same fashion as recorded music has done during more than half a century" (p. 142-143). Thus, researching new methods for creating impactful live music experiences is a worthy investment.

[2] http://xylobands.com

[3] http://nanikawa.com/projects/kasabian-tour-2011-interactives

1.2.1 Research Methods

To address the research question, I will be implementing two forms of qualitative research – ethnographic study and user-centred design.

1.2.2 Scope

Some delimitations will be enforced to ensure the research remains focused.

1.3 Overview

- **Chapter 2: Literature Review**

  An overview of the history of music and performance is provided, and presentational and participatory performances types are compared. I examine how presentational performance has grown into what it is today and how rock music and modern technologies have been bringing participation back into live music. Work in HCI is referenced to explore group-controlled systems, creative collaboration, and audience-performer interaction. Real-world audience-based lighting systems are also reviewed.

- **Chapter 3: Ethnography**

  The research questions are examined from both the audience's and the performer's point of view. This is accomplished through a survey of music fans and interviews with musicians.

- **Chapter 4: Protoyping**

  I describe the production of three prototypes. This includes the objectives of the prototypes, their development processes, user testing, and analyses of the results.

- **Chapter 5: Conclusion**

  To conclude, I summarize the overall outcomes of my work and discuss possible future directions for the project.

Chapter 2

Literature Review

2.1 Background

This section investigates music's significance as a social activity among humans. The concepts of participatory and presentational performances are explained and contrasted. I discuss how capitalism led to the rise of presentational performance and how mass media turned it into a visual spectacle. Lastly, I consider rock music and suggest that mass media could also be the key to making the modern concert more participatory.

2.1.1 Music and Community

Music is a part of being human. "The archaeological record," Daniel Levitin (2006) explains, "shows an uninterrupted record of music making everywhere we find humans, and in every era" (p. 256). Early music making was purely rhythmic, with simple objects being used as percussion instruments. As primitive wind and string instruments were crafted, rhythm was joined by melody. Music making gradually evolved in cultures all over the world, and it has grown to serve many different purposes. In New Guinea it is a gift to one's host; in the Democratic Republic of the Congo it is used to settle lawsuits; Australian aboriginals use music to tell intricate stories; and some African tribes believe repeating musical chants can draw harmful spirits out of inflicted individuals (Jourdain, 1997; Turner, 2011). In modern

Western cultures, of course, music is everywhere – performed at live concerts, scoring film and television, being shared on the Internet. Regardless of culture, there is no denying that music is an inherently social activity.

Why did music evolve with humans? Anthropologists believe it may have initially been a tool for social bonding, or perhaps a clever survival method (Jourdain, 1997; Levitin, 2006). A drum circle around a fire could have improved a group's coordination, but it may have also served to keep everyone awake and ward off predators. In less primitive societies, music is still valuable as a social activity. Musicologist Thomas Turino (2008) talks about the benefits of making music with others – what he calls "sonic bonding." Referencing the work of anthropologist Gregory Bateson, Turino posits that such artistic experiences promote deep connections to others that are crucial for "social survival." Thus, music making may be a strong tool in forming and developing rewarding relationships. Christopher Small (1998) suggests that live music performance forms communities that represent ideal relationships; in the moment, participants can forget reality and feel one with those around them. Anthropologist Edith Turner echoes this idea, referring to a concept called "communitas." "Communitas," she explains, "occurs through the readiness of the people – perhaps from necessity – to rid themselves of their concern for status and dependence on structures, and see their fellows as they are" (p. 1). Turner identifies communitas at work at sporting events, in the workplace, and even during disasters, but she claims music to be the most reliable source of communitas. Music is ephemeral, emotional, and it cannot be constrained by rules. "Its life is synonymous with communism, which will spread to all participants and audiences when they get caught up in it" (p. 43). Though we cannot share our bodies with one another, Turner explains, music allows us to share time. It is clear that live music performances can be powerful events; it is important to realize, however, that not all performances are the same.

2.1.2 Participatory and Presentational Performance

In his book *Music as Social Life: The Politics of Participation* (2008), Thomas Turino divides music performance into two categories – participatory and presentational. Most cultures exhibit some sort of participatory performance. Peruvian communities perform in large groups with each participant either dancing or playing a panpipe or flute; many different religious ceremonies involve singing in unison or in a call-and-response structure; line dancing in North America features choreography that is closely tied to the music. In general, the emphasis is on the intensity of the interactions over the quality of the performance, and participatory performances have characteristics that support this. In a purely participatory performance, Turino explains, "there are no artist-audience distinctions, only participants and potential participants performing different roles, and the primary goal is to involve the maximum number of people in some performance role" (p. 26). Equality among participants can lower self-consciousness and lead to a more relaxed atmosphere. Having different roles, on the other hand, allows individuals of different skill levels to contribute accordingly. "Core" and "elaboration" roles, in Turino's words, cater to less- and more-advanced performers, respectively; core participants keep the performance moving along while elaboration participants add flourish. Another common feature of participatory performances is repetitiveness. This open form allows newcomer participants to easily join in. Additionally, Turino explains, there is a "security in constancy" that allows performers to become more comfortably immersed in the music. Performances may also incorporate loud volumes, densely overlapped sounds, and loosely tuned instruments as "cloaking functions" to make individuals more comfortable participating. Solos are not common, although sequential soloing sections are sometimes included; karaoke is an example of sequential participatory performance. Overall, participatory performances allow all participants to feel as though they are contributing, and this makes them quite different from presentational performances.

In a presentational performance, the performer presents prepared music pieces to an audience that does not directly participate in the performance (Turino, 2008). A typical

Western rock concert is a good example: a band on a stage performs rehearsed songs to an attentive audience whose main role is listening to the music. In contrast with the open form of participatory performances, here there is a focus on detail, smoothness, and coherence. These performances are generally closed form; the artist knows how the show will begin and end. While participatory performances rely on constancy, planned contrasts are implemented in presentational performances in order to keep the audience's attention. A rock band will often break up a song with a guitar solo, for instance. Participatory performances foster connections between participants, Turino explains, whereas presentational performances seem to tease a connection between artist and audience without ever realizing it: "Leave them wanting more." Indeed, the goal of a presentational performance is typically to sell as many tickets as possible. It is, in fact, this desire for profit that has progressed the evolution of presentational performances over the last few centuries.

2.1.3 Presentational Performance: A Lucrative Spectacle

Public concerts were virtually unheard of before the 1600s (Jourdain, 1997). Outside of church, commoners rarely had the opportunity to hear "serious" music, and any other music performance was relaxed and participatory in nature. The 'professional' musicians of this era, musicologist Christopher Small (1998) explains, were those hired by aristocrats to accompany them as they played. It was not until the time of the Industrial Revolution that savvy musicians realized that the newly established middle class would regard live performances as opportunities to display their newfound wealth. These "traveling virtuoso-entrepreneurs" made money touring from town to town and performing in local parlours for a fee. By the 1800s, ticketed events were gradually becoming more abundant and "art music" concerts began transforming the state of the live performance. These were seen as formal events, says Jourdain, and those wealthy enough to attend were expected to follow the established etiquette – sitting quietly and listening. Presentational performance thus emerged as a product to be enjoyed by those who could afford it. Over time, it has become increasingly important that they provide as much value for patrons as possible.

Presentational performances have been enhanced in many ways using technology. Arena rock concerts, for instance, make use of arrays of powerful speakers, dense lighting rigs, and multiple giant screens, sometimes also incorporating huge stage pieces and complex mechatronics. The main function of this equipment is to amplify the sights and sounds of the performance. As Kelly (2007) explains, however, it also serves to amplify the persona of the performer. Large screens may show closeups of the performers on stage, but they also often display video clips or abstract visuals designed to reflect the performer's image and communicate underlying themes. Showing clips from Madonna's old music videos as she performs, for example, influences audience members' emotions using nostalgia. This can also unify fans by creating a "shared past" amongst them, says Kelly. Similar technologies are being used in even more abstract ways by groups like Gorillaz – an alternative rock band fronted by fictional characters. Live performances often feature real musicians silhouetted by projections of the cartoon band members. German electronic band Kraftwerk took it a step further for live performances of their song "Robots," leaving the stage entirely and being replaced by robotic stand ins for the duration of the song. The fact that audiences will cheer for a stage void of the performers indicates the influence technology has had on live performance. Compelling visual elements, specifically, are becoming increasingly essential in modern concerts.

So why are visuals such an important part of modern music performances? Media studies professor Jamie Sexton (2007) points out that music is always tied to other media; things like music videos and even album art can affect the way songs are experienced. "Musical meaning ... emerges from its relationships with other media," Sexton posits (p. 2). Philip Auslander (1999) provides another perspective. Live performance and mass media are in competition, he says, and, since mass media is dominating, live performance has responded by imitating its competitor. Live sporting events make use of big screens and instant replays, for instance, and television shows and movies are regularly adapted for the stage. Live music performances, similarly, have been greatly influenced by MTV. As Music Television reached the height of its popularity in the 80s and 90s, concerts began looking more and more like music videos. For example, Madonna's live performance of "Like A Virgin" at the 1984 MTV Video Music Awards played out like a music video, the singer performing directly to the multiple television cameras and virtually ignoring the large audience beyond the stage (Burns, 2006). Jaap Kooijman (2006) points to Michael Jackson's performance of "Billie Jean" at the 1983 *Motown 25* concert, where Jackson's outfit and dancing directly referenced the song's music video. The crowd cheered as Jackson exhibited his signature dance style – never noticing, or perhaps never caring, that he was lip-synching the vocals throughout. It seems, then, that mass media is responsible for turning concerts into the multi-sensory spectacles that they are today.

2.1.4 Rock Shows and Participatory Culture

A concertgoer today is much more a consumer of the performance than a participant in it. David Horn (2000) provides the following definition:

> The popular music event is the sum of a number of smaller occurrences, which might include any or all of the following: the origination or the borrowing of a musical idea; the development of the idea; the conversion or arrangement of the idea into a performable piece; the participation of those (musicians, producers, technicians) whose task is to produce musical sound; the execution or performance of this task; the transmission of the resulting sounds; the hearing of those sounds (p. 28).

Out of all of the tasks associated with a live show, the audience is given one – hearing. As Jourdain (1997) explains, this spectatorial role developed as performers began "dominating" over the audience. In the 1800s, conductors began locking latecomers out of the theatre, silencing applause, and ignoring popular requests. Musicians started dressing in matching uniforms, further setting themselves apart from the audience. Audiences are now further dominated by the booming speakers that drown out their voices and the bright lights that make the performer blind to them. Even the audience's primary tool – applause – is losing its power. As Baz Kershaw (2001) explains, standing ovations, once rewards that had to be earned by performers, are today dispensed almost without question; the standing ovation is now "an orgasm of self-congratulation for money so brilliantly spent," he says, rather than a democratic device (p. 144).

This inequality established by art music in mainstream performance has been consistently challenged since the emergence of rock and roll. Rock shows are typically environments that encourage audience involvement – presentational performances with participatory leanings. Crowds join the music making by clapping or singing along, for example. They add to the light show by holding up lighters or illuminated cellphones. Some musicians invite fans to shout out song requests. Perhaps the simplest way for an audience member to become a participant is to move to the music; swaying, dancing, or joining the mosh pit are all methods concertgoers use to connect to performances. Although some performers are particular about how audiences behave (Neil Young[1] or Queens of the Stone Age[2], for example), others go out of their way to make audience members central to the performance. Elvis Costello has toured with a "Wheel of Songs," for instance, inviting audience members to spin the wheel and determine what tune the band will play next. The Flaming Lips give audience members ridiculous costumes and let them dance behind the band for entire concerts. Green Day, playing to thousands of fans, will pull a select few on stage and allow them to play the band's instruments for one song before sending them backstage to enjoy the after party. These sorts of interactions between musicians and their fans are becoming increasingly ordinary, and the culprit once again appears to be mass media.

The Internet has changed the face of mass media; in particular, it has drastically altered the relationship between content creators and their fans. Communication studies researcher Nancy Baym (2012) describes the traditional audience-performer relationship as "parasocial" – one-sided, with most information flowing from the performer to the audience. The notions of 'rock gods' and 'pop stars' once framed musicians as untouchable beings. Today, however, increased connectivity on the Internet has brought the two parties closer

[1] http://nme.com/news/neil-young/74774

[2] http://pitchfork.com/news/53876-watch-queens-of-the-stone-ages-josh-homme-action-bronson-throw-people-off-stage-this-week

together; some musicians, says Baym, even see their fans more as friends. A multitude of social media services allows performers and audiences to communicate and even collaborate, creating what Patrik Wikström (2013) fittingly refers to as a “participatory culture.” Artists directly respond to fan message on Facebook or Twitter, for example, and organize in-depth question-and-answer sessions with the Reddit community. They invite fans in to their personal lives by posting photos from their daily life on Instagram. Soundcloud[3] allows listeners to post comments as they listen to a song, praising or critiquing certain parts of the track. With crowdsourcing services like Kickstarter, artists ask fans to directly fund their projects; musician Amanda Palmer most famously raised over $1 million from 24 800 supporters to fund an album, a book, and a tour[4]. Many artists ask fans to create remixes of their work, and new services like BLEND.IO[5] facilitate this kind of collaboration. “Social and creative music use,” Wikström explains, “is the normal way in which music fans use music in the new economy” (p. 171). While this dynamic is prominent on the Internet, it also has implications in the live setting.

In a participatory culture, social networks form around live events. A simple example is an online event page, where fans can learn more about an upcoming performance, see who else plans on attending, and communicate and share with other fans. Some artists reach out to attendees beforehand as well. Alternative rock band Wilco, for example, allows fans to request songs for specific tour dates on their website. Many music festivals make use of social media, displaying messages or photos posted by audience members on Twitter or Instagram. Artists often share their own show photos as well. Toronto band Born Ruffians, for instance, take photos of their fans from on stage and post it on Facebook, allowing attendees to find and tag their faces in the crowd. The practice of ‘bootlegging’ – recording concert audio to be shared with other fans – has existed for decades in rock music. While this activity is surrounded by legal issues, many artists openly encourage it; the Grateful Dead and Phish

[3] http://soundcloud.com

[4] http://kickstarter.com/projects/amandapalmer/amanda-palmer-the-new-record-art-book-and-tour

[5] http://blend.io

are two well-known examples. Today, artists like Bruce Springsteen and the Red Hot Chili Peppers are saving would-be bootleggers the trouble and providing free professional live recordings online after each show. Video recording has become a contemporary version of this practice. Fans film some or all of a performance on their personal devices and post the videos online. As with traditional bootlegging, some artists protest this, explicitly asking fans to keep their devices in their pockets[6]. Radiohead and the Beastie Boys both embraced the concept, on the other hand, using fan-shot footage to create multi-perspective concert videos. Welcoming sharing in this way forms new relationships between performer and audience.

As we have seen, performance responds to the culture it exists within. For primitive societies, music is purely participatory, more functional than entertaining. Presentational performance eventually emerged as a way for the middle class to flaunt their newfound wealth. It morphed into a visual spectacle when mass media created a visual culture and MTV made music and images inseparable. Today, there is a participatory culture forming, and I believe that live performances will continue changing to reflect this. The next section presents research that investigates audience participation and new technologies that facilitate it.

2.2 Related Work

Relevant work in human-computer interaction is referenced in this section, exploring crowd-based interfaces and audience-performer interaction. Case studies are also presented on projects that were implemented at large-scale events with popular music artists.

2.2.1 Crowd-Based Interfaces

Designing for large groups of people has only recently attracted substantial interest in the field of human-computer interaction (HCI). The recent ubiquity of public displays,

[6] `http://stereogum.com/1400701/she-him-are-the-latest-act-to-ban-camera-phones-via-patronizing-signage/news`

networked personal devices, and location and movement tracking technology is allowing for new possibilities in this area, Brown et al. (2009) explain. These authors emphasize that designers must take into account not only individual user experiences, but the experience that will emerge from a large assembly of users. There are many different types of crowds, of course. A crowd may be made up of similar or different people, anonymous or acquainted with each other. Their attention may be dispersed, or they may have a shared focus. They could be acting independently or toward a common goal.

The following research investigates different methods for giving a crowd control over a system. The contexts vary from interactive dance clubs to multiplayer games to sports judging systems.

Ulyate and Bianciardi

Ulyate and Biancardi's 2001 paper describes the Interactive Dance Club, a venue that delivers audio and video feedback to inputs from multiple participants. The goals of the project were to create coherent musical and visual feedback for individual and group interactions and to allow non-artistic people to feel artistic. Researchers placed emphasis on intuitive and responsive controls, obvious and meaningful feedback, and modular design. Inputs were based on movement and captured using light sensors, infrared cameras, pressure-sensitive tiles, proximity sensors, and simple mechanical switches. By interacting with these devices, users could make notes sound out, manipulate projected video and computer graphics, modulate music loops, and control the position of cameras in the space. The authors share the lessons learned while testing the concept. They observed that interactions involving full-body movements were most satisfying for users. The form of an object clearly determined how users first attempted to interact with it. They emphasize the practicality of a system that is both distributed and scalable. Designing the interactions required finding a balance between freedom and constraint. They found that, no matter how elegant the system, some users would still find a way to create unpleasant noise. Lastly, they observed that instant gratification is important; feedback that is too delayed or interactions that require too much concentration are ineffective.

Maynes-Aminzade, Pausch, and Seitz

Maynes-Aminzade et al. (2002) developed three different computer vision systems that allow an audience seated in a theatre to control an on-screen game. The first method tracked the audience as they lean to the left and right; the control mechanism was intuitive, but the system required frequent calibration. The second method followed the shadow of a beach ball which acted as a cursor on the screen; this was also intuitive, but it only involved a few people in the audience at any given time. The third method tracked multiple laser pointer dots on the screen, giving each audience member a cursor; this became somewhat chaotic once a large number of users started participating. Next, the authors present some guidelines for designing systems for audience participation. They recommend focusing on creating a compelling activity rather than an impressive technology; they state that every audience member does not necessarily need to be sensed as long as they feel like they are contributing; and they suggest that the control mechanism should be obvious or audience members will quickly lose interest. The authors also note that making the activity emotionally engaging and emphasizing cooperation between players will increase the audience's enjoyment.

Feldmeier and Paradiso

In their 2007 study, Feldmeier and Paradiso present a scalable system for wirelessly tracking the movement of a large number of users, allowing a crowd of dancers to influence techno music and lighting in a club. Citing limitations in computer vision technologies, the researchers decided to use handheld devices as an input mechanism. Users were given cheap and lightweight sensors that emitted radio frequency (RF) pulses when they experienced accelerations over a certain threshold. The music responded to users' movements subtly at first, triggering long, droning tracks. However, if the crowd managed to dance in sync for an extended amount of time, the system would move to a higher "energy level," and the users would be rewarded with the ability to trigger more interesting melodies and percussion tracks. Receivers placed throughout the club had low sensitivity, effectively producing small "zones of interaction" around which users would gather. Reflecting on the experiment, the researchers found the devices to be effective – with low latency, cost, and power requirements. They felt that they succeeded in giving dancers control over the music and took advantage of the crowd's tendency to move in sync. Future work would investigate how to give users even more control while keeping the output aurally pleasing.

Tomitsch, Aigner, and Grechenig

Tomitsch et al. (2007) investigated how simple devices might be used to allow spectators to participate in the judging of sporting events. They formulated a hypothetical system to involve audience members in the scoring process of subjective Olympic events (such as figure skating or gymnastics). Each ticket holder would receive a disposable wristband containing a motion sensor, LED, and RF transmitter. The devices (inspired by those in the above study) would send RF pulses when users clap, and their LEDs would illuminate to indicate that the pulse has been sent. Receiver stations would count pulses and analyze the frequency of the clapping. Finally, a combined audience score would be calculated based on clapping frequencies in combination with loudness readings from microphones placed around the venue. The authors felt that clapping was an input that could be universally understood, regardless of a user's background. Because many receiver stations could be networked together, they suggested that the project was easily scalable. Tomitsch et al. also propose that making the devices disposable would frame them as souvenirs and increase acceptance by users.

2.2.2 Audience-Performer Interaction

The above research provided valuable insight on crowd-based interactions; however, there are additional considerations when the system must facilitate another type of user – the performer. This section details research that investigate how an interactive system might be incorporated at a live performance.

Bongers

In his 1999 paper, Bongers provides a theoretical HCI framework for physical interaction between performers, audience members, and electronic systems in a musical performance. He defines three types of interaction – "performer-system", "system-audience", and "performer-system-audience." Bongers models the interactions as control systems wherein events are either a control or feedback process. Systems facilitate these processes through electronic sensors and actuators, whereas humans utilize senses and motor systems. Bongers states that a more convincing interaction is one that provides "multimodal" feedback – influencing more than one of the users' senses. Lastly, a few prototypes of novel interaction systems are described. Especially notable is the "Interaction Chair", which most easily fits in the performer-system-audience category. Here, the performer has the ability to send vibrations through each audience member's seat back, while the chairs contain sensors that allow audience members to influence visuals projected behind the performer.

Gates, Subramanian, and Gutwin

This 2006 paper examines the complex interactions between DJs and audience members in nightclubs from an HCI perspective. The authors gathered their information by observing behaviours at nightclubs, surveying DJs, as well as conducting lengthy interviews with them. Most DJs had similar preferences and performance styles. For example, all of the interviewees said they preferred venues where audience and DJ are mutually visible; this allows them to adjust their performance based on visual cues from the audience. Using quick glances, DJs can observe audience members' facial expressions and body language and the flux of people on to and off of the dance floor. Many DJs stated that they will often exaggerate their movement or speak into a microphone to energize the crowd. Small, direct interactions can also occur between DJs and audience members, such as exchanges of facial expressions or gestures. DJs use the information they glean from their audience to shape their performance. Most DJs will craft a playlist before performing based on the venue, event type, and expected audience; during the performance, however, the energy of the crowd ultimately guides how the tracks are mixed. In general, the authors found that, as long as there is sufficient visibility, DJs are extremely competent at adjusting their performance based on the audience. Interviewees saw little need for technology to aid their performances; one of the few wishes the DJs expressed was for a method to discover the musical preferences of a given audience.

Based on the information collected, the authors present some design recommendations for those wishing to bring interactive technologies to nightclubs. For example, they state that, considering how skillful DJs are at observing audiences, any technology meant to gather information from the crowd must be more efficient than DJs themselves. Such technology, the authors suggest, would be most useful for gathering “invisible” information like musical preferences. They recommend against using biofeedback systems or systems where audiences have a direct influence on the performance; these methods do not help DJs do their job. The researchers state that gradual changes are more satisfying than immediate ones. Lastly, they emphasize the importance of respecting the DJ’s art; technologies should allow them to stay in control of the music and should not add to their already-demanding cognitive load.

Barkhuus and Jørgensen

Barkhuus and Jørgensen’s (2008) paper investigated interactions between audiences and performers at a concert. The authors used observations from traditional rock and rap shows to inform the design of a simple ”interaction-facilitation technology” – a cheering meter. By tracking the applause patterns at several concerts, it was determined that the two most common reasons for cheering were to express anticipation and to reward the performers. This led to the creation of a cheering meter, an instrument for measuring the volume of an audience – in this case, to determine the winner of a rap battle. Microphones captured samples of the crowd’s cheering, the signal was filtered, the peak volume was measured, and the rating on an arbitrary scale was displayed on large screens onstage.

The researchers reported no major issues while testing the system, and they express confidence that their technology helped to enhance the concert for the audience members. In their paper, they outline the main reasons for the cheering meter's success. First, the authors state that the usability of the system is due to the fact that it is based on an already-present behaviour; they recommend "designing technology that fits the situation and which utilize present activities rather than aiming to employ the latest cutting edge technology" (p. 2929). Next, they suggest that an event should not rely on the success of the technology; the rap battle, for example, could have easily continued if the cheering meter malfunctioned. Lastly, the authors emphasized the importance of immediate visual and/or aural feedback; seeing direct consequences of their actions gives the audience confidence in using the system. This research focused on a very specific type of event using an almost-gimmicky system, but the design principles it yielded are valuable.

Tseng et al.

This paper from 2012 describes the motivation and creative process behind a Taiwanese interactive theatre experience that let audience members connect with a dance performance. The project was realized using projection mapping, a Kinect, a local area network, and a custom iPhone app. Audience members downloaded the app before the show and entered a code corresponding to their seat number to connect to the local network. During the first part of the performance, each user was given control over one "light dot" projected onto the stage. The dot could be moved by moving the iPhone; users could also point their phone's camera at different light sources to influence the brightness of their dot. Later in the performance, audience members could use their phones to trigger sounds and projected images onstage. The dancer, tracked by the Kinect, interacted with the projections, improvising a dance with the light.

The authors approached this project by asking, "How can the audience become an essential element in a performance?" (p. 561). They claim that, while new media has been incorporated into theatre for decades, mobile phones have not been used to their full potential. Feedback collected after the performance revealed overall positive reactions.

Some users, however, were uncomfortable having their personal devices connected to an unfamiliar network. Another negative was that not every audience member owned an iPhone; one of these spectators, though, maintained that she enjoyed the show even while being excluded from the interaction.

2.2.3 Case Studies

Some of the work outlined in this section has been implemented by widely-known artists like Usher, Arcade Fire, and Coldplay. While the first two examples invite audience members to contribute to the musical output, more recent projects are instead putting lights and visuals in the crowd's control. One example enables the participation of absent users who are watching online.

D'CuCKOO's MidiBall

D'CuCKOO, a band active in the 1990s, frequently incorporated technology into their live shows[7]. They invented and constructed several MIDI-based electronic instruments and played them alongside traditional instruments, performing pop music with hints of techno and dance. The MidiBall was a large, helium-filled ball that triggered sounds and visuals on stage when struck by audience members. As D'CuCKOO performed, they let the ball bounce around the crowd and accompany their music.

Plastikman's SYNK

Plastikman, the alias of electronic musician Richie Hawtin, had a smartphone application developed to accompany his 2010/2011 world tour[8]. The app is activated when it connects to the Wi-Fi network at a Plastikman performance, and various modes are enabled as the show progresses. "Konsole" mode displays live performance information such as the tempo and names of the tracks being played. "Kamera" provides a live video stream of the performer's perspective. "Synkotik" displays visuals that are synchronized with on-stage

[7] `http://telecircus.com/yeold/Side/Dcuckoo`

[8] `http://hexler.net/software/synk`

visuals. Lastly, "Logikal" allows users to rearrange audio samples using their touch screen which influences the sounds played by the performer. Before and after the performance, users could connect with each other in the app's chatroom.

Kasabian's Interactive Stage Show

UK-based studio Nanika helped Kasabian bring audience members into their live shows by making their faces part of the stage show[9]. Cameras captured video of the audience, and face-tracking software identified individual audience members. Visualizations were then applied to the footage, highlighting the tracked faces and drawing lines between them. The resulting video was then projected on the backdrop behind the band. Audience members were excited to see their faces on the giant screen.

Amex Unstaged: Usher

An Usher concert streamed online in 2012 allowed at-home viewers to participate in the show[10]. After posting tweets through the website, users' words appeared on screen behind the performers, mixed with stylized visuals. Online users could also create an animated avatar which virtually danced behind Usher during the performance of his last song.

PixMob

PixMob is a patented wireless technology that enables the control of multiple LED-embedded objects[11]. By giving PixMob objects to spectators, concert producers can create a controllable LED light show within the audience. The objects are activated with signals from infrared transmitters. Like normal lighting fixtures, the transmitters' beams can be shaped with lenses and controlled via the DMX512 protocol. The objects light up when they are hit by a beam, so patterns of moving light can, in essence, be painted across the audience. Light shows are programmed, simulated, and controlled through a software package called

[9] `http://nanikawa.com/projects/kasabian-tour-2011-interactives`
[10] `http://momentfactory.com/en/project/stage/Amex_Unstaged:_Usher`
[11] `http://pixmob.com`

LAVA; they can also be controlled in real time using a MIDI controller or the LAVA iPad app. Previous PixMob objects include balls, wristbands, pendants, and beads, and custom object creation is available as well. PixMob also offers “second life” customization: objects can be programmed to react to sounds, play an mp3 track, or communicate with the user’s personal computer after the show is over. Past clients include Microsoft, Arcade Fire, Eurovision, and Heineken.

Wham City Lights

Wham City Lights is a smartphone application that allows multiple devices to display light shows in sync during a concert[12]. Audience members with an iOS or Android device can download the app before the show. Once the show has begun, an operator activates lighting cues by playing encoded, ultrasonic tones; devices with the app open “hear” these tones and perform the corresponding cues. This can be done at nearly any scale as long as every device is able to hear the tones. Users generally hold their devices up or wave them above their heads during the show. Light shows can be created live or programmed in advance using an online editor; cues include flashing colours, camera flashes, GIFs, text, and sound.

The concept was originally developed by US musician Dan Deacon. His intention was to prevent concertgoers from using their personal devices and disengaging during live performances. Deacon tested the app at his own shows and received a positive response. Today, Wham City Lights licenses their general-purpose app for different kinds of events; they also develop custom apps to include branding, tour dates, etc. Musicians and organizations like Brad Paisley, the Billboard Music Awards, and Intel have made use of this technology at their events.

Xylobands

Xylobands are controllable LED wristbands designed to be worn by potentially thousands of users at entertainment events[13]. They are controlled using a proprietary piece of software

[12] `http://whamcitylights.com`

[13] `http://xylobands.com`

downloaded to a laptop; the laptop must then be connected to a radio transmitter. With the software, an operator can turn the Xylobands on or off, select which colours are illuminated, and control the speed of the LEDs' flashing. The transmitter has a range of around 300 meters. Each wristband contains a small printed circuit board that holds, among other components, an RF receiver and an 8-bit microcontroller. The electronics are powered by three 3 V coin cell batteries.

The technology was originally developed for the band Coldplay, and wristbands were handed out to all concertgoers during their 2012 world tour. Giving the wristbands to each audience member at every performance reportedly cost the band €490 000 (around $680 000 CAD) per night[14]. UK-based toy development company RB Concepts Ltd. are the creators of the Xyloband. Their website advertises that Xylobands can be customized and used at concerts, festivals, sports stadiums, or corporate events.

[14] `http://rte.ie/ten/news/2012/0615/438139-coldplay`

Chapter 3

Ethnography

One of my first goals was to get a sense of modern concertgoers' and performers' feelings about participatory performances and interactive technology. I sent out a brief online survey for music fans that helped me to understand how they generally responded to these topics. Interviews were also conducted with multiple musicians to shed light on their perspectives.

3.1 Audiences

An online survey was created in order to obtain a sample of modern music fans' opinions on interactive performances. The survey was completed by ninety-nine participants recruited via social media. The first few questions informed me of what type of concertgoer each participant was – asking their favourite genre, the size of the venues they frequent, and how often they attend live music performances. I also asked how often the participants communicate directly with musicians through their social media presences. Next, the survey focused on concert behaviours. Participants were asked in which actions they typically partake at live music performances; choices included applauding, headbanging, and holding up lighters. They were asked how they might like to interact with their favourite performer and what sort of message they would send them if they could. I asked for their thoughts on getting involved in performances, bringing new technologies into concert settings, and interacting with musicians using social media services. (For complete results, see Appendix

X.)

The results were not shocking but certainly informative. Most participants favoured rock music or some variation ("indie," "alternative"); the majority attended multiple concerts per year – some even on a weekly basis; and most usually went to shows at small- to medium-sized venues. The majority of participants claimed to communicate with artists through social media either sometimes or regularly, though a sizeable amount indicated they never do this. The most popular concert actions were applauding, singing along with the performer, clapping or stomping to the beat, dancing, jumping up and down, and chanting words or phrases along with the other audience members. When asked how they might want to interact with a performance, many said they would like to choose the songs that are played, while much fewer expressed interest in manipulating visuals and contributing to the music; around one quarter of participants stated they did not have interest in directly influencing a live music performance at all. Given the opportunity to communicate with their favourite performer, most participants responded with praise or appreciation ("Thank you," "I love you!"). Other messages included song requests and suggestions like, "Don't bury the vocals," or "More rock, less talk!" The majority of participants indicated that they enjoy when performers ask them to participate in a performance – clapping or singing along or call and response, for example. Lastly, the majority also said they were excited by the idea of bringing new technologies into a live music setting.

Upon further analysis of the responses, some correlations were uncovered. There are clear relationships between show-going frequency, venue size, and interest in interaction and technology. Participants attending shows more frequently are more likely to visit smaller venues. This group also expressed the most interest in being involved in performances; they are more inclined to interact with their favourite artists via social media; and they are more welcoming to the idea of unfamiliar technology in a concert setting. The opposite, thus, can also be said: participants who go to fewer shows tend to go to larger venues, are more likely to refrain from participating in shows, are less likely to contact artists through social media, and are less interested in new technologies.

3.2 Performers

With a broad overview of audience attitudes, the next step was to speak directly with actual performers and discuss the same topics with them. Three musicians were recruited – Erik Grice, Blake Enemark, and Christian Hansen. These three were selected because I was familiar with their bands and felt that they represented three distinct performance styles within the rock genre. The subjects have different backgrounds as performers, experience playing in different parts of Canada, and for a range of audience sizes. They also have slightly different relationships with modern technology. While their opinions are representative of modern rock musicians, it should be kept in mind that these subjects are also music fans who enjoy watching others perform as well; thus, they are also sharing their perspective as concertgoers.

After briefly establishing their history as performers, I asked them each about what audience participation means to them. The musicians were shown video of some of my case study subjects (including Xylobands, Wham City Lights, and Kasabian's 2011 tour), and I recorded their reactions and general thoughts on technology-enabled performances. Lastly, the artists were asked if and how they would want to incorporate similar participatory technologies into their own shows.

3.2.1 The Subjects

Erik

Erik Grice grew up outside of Edmonton, Alberta. He performed musical theatre as an adolescent and started playing in bands in his teens. After acting as a vocalist and guitarist in previous bands, Erik now plays drums for Edmonton-based The Fight – an alternative rock band with soul undertones. The Fight's typical audience size can range from twenty at road shows to over one hundred people at home shows. Venues are usually small clubs or halls. They have also played acoustic shows at cafes or similar venues. A typical Fight concert is energetic yet composed. Audience members can comfortably move to the music and may be welcomed to sing along with certain choruses.

Blake

Blake Enemark is originally from Victoria, British Columbia. He picked up guitar as a teenager and started playing covers in bands. Blake recorded and toured with alt-country band Forestry in 2010. Shortly after, he was recruited to join We Are The City, a Vancouver based progressive rock band who had just gained nation-wide recognition after winning the $150 000 Peak Performance award. With this group, Blake experienced audience more sizeable and fanatic than he had experienced before, culminating in a performance for around two thousand people in Vancouver's Stanley Park. Blake parted ways with We Are The City shortly thereafter, going on to tour with folk group Northcote, before starting his own project called Snoqualmie. Snoqualmie, described as "high-gain, sad-sack Canadiana," marks a return to songwriting and more intimate shows for Blake.

Christian

Christian Hansen has a theatre background, a graduate of the University of Alberta's acting program. He began playing in bands as a teenager. During his university degree, Christian rediscovered his desire to perform music and began playing acoustic shows. He eventually started performing with his now-wife Molly and began incorporating drum machines and prerecorded tracks into his work, which was becoming more like dance music. Christian Hansen & The Autistics were formed. When Molly could not make it to one show, Christian was inspired to put all of his energy into his performance to make up for it; this was a "lightbulb moment for him." Christian Hansen & The Autistics soon gained notoriety around Edmonton for their high-energy shows, and their songs received a lot of radio play. Christian and Molly moved to Toronto in 2011, shortening their band name to Christian Hansen and now playing music described as new wave. While they are currently working their way into Toronto's music scene, Christian Hansen typically draw around five hundred excited showgoers when they play in Alberta.

3.2.2 Interacting With Audiences

Erik

The Fight encourage some forms of participation at their shows. Their lead singer can often walk out and physically touch audience members, looking them in the eye as he sings. They will invite the crowd to sing and/or clap along for suitable songs. Erik felt that this sort of participation typically makes for better shows: "An attentive and participating crowd of fifty people is always going to be better than two hundred people who are standing there with blank faces." He explained that the ideal audience will match the energy that the band exudes. In addition to making the show more enjoyable, he said, this also makes musical flubs less significant to everyone present. Erik felt that it is the band's job to keep the audience's attention. They must make decisions based on the venue, the audience, the length of the set. Stage banter is usually only implemented to convey pertinent information to the crowd. Talking to audience members after the show has gotten the band extra shows, radio spots, places to stay for the night.

The Fight make use of popular social media channels. They use Facebook to advertise, organize contests and giveaways, and share information on their live dates. Twitter is used for communicating with fans and other artists. This has helped them open slots for touring bands. At shows, the band hands out cards with links to their social media pages. Erik believed there is a levelling out between artists and fans, and he likes this. He explained that some contemporaries try to maintain personas and seem "untouchable": "It's stupid to have those kinds of pretences," he said. He noted that, for larger bands, direct interaction with fans is more difficult, but overall the extra freedom is nice.

Blake

Blake is a self-described introvert. While he is certainly the leader of his current band, he expressed a preference for playing in the background. Despite being typically shy with audiences, Blake recognized the significance of even basic audience participation. Singing and clapping along makes you feel like a part of the show. He also expressed the impact this might have on performers; “It would be the most flattering thing in the world for me for someone to sing my song back to me,” he said. Blake noted, however, that different performers react to audience participation differently. A guitarist in his former band, for instance, would not allow the audience to clap along. Furthermore, “There’s a fine line,” Blake stated, “between drunken participation and intentional participation.” He acknowledged the prominence of alcohol in live music settings and the importance of alcohol sales at most venues. It is a part of the industry, he said, and it plays a role in how audiences behave.

The internet presence of Blake’s current band is “not very good.” Blake himself recently closed his Facebook account for personal reasons. Despite this, he recognizes the importance it holds for artists: “It’s bridging gaps that have never been bridged before.” He had an especially meaningful experience with the Reddit community; after an anonymous user posted a link to his music, Blake began receiving orders from all over the world – the southern United States, Poland, Japan. “You never know who’s listening,” he said, “It’s empowering and terrifying.”

Christian

Christian felt that it is the responsibility of the performer alone to ensure a concert is enjoyable. If he puts all of his energy into a show, he explained, all he can hope is that the audience reciprocates: “If we come in at 200%, maybe the audience will get to 100%.” Christian emphasized the importance of responding to the audience. If they are standing far from the stage, he will encourage them to get closer. If certain individuals are especially invested in the show, he will make eye contact with them and sing directly to them. Christian encourages singalongs and will sometimes hold the microphone in front of those who are singing loudly. He may even leave the stage and make physical contact with the crowd if they seem particularly comfortable. At their most recent Edmonton concert, Christian entered the audience and performed the last song unplugged, the crowd surrounding him and singing along with him. For him, this moment as “amazing, magical.” While he acknowledged that every audience is different, Christian felt that getting the audience involved generally increase the intensity of a show.

Christian embraces connecting with fans through social media. He accepts friend requests from fans on his personal Facebook account and does his best to respond to every message he receives. Despite a few negative online experiences, he Christian enjoys interacting with fans in this way.

3.2.3 Participatory Technologies

At this point in the interview, the musicians were shown images of some of the projects that were outlined in Chapter 3. These included PixMob, Xylobands, Wham City Lights, Plastikman's SYNK, and the Amex Unstaged: Usher project.

Erik

Erik responded negatively to the projects that relied on smartphones; he feels they would be mostly distracting, and he expressed concern about possible being responsible for people dropping and damaging their devices. "What can't your phone do now?" he asked. Rather, he favoured the work that had other tangible elements, like the PixMob beach balls. Erik felt that every show should be unique. An attendee should be able to go home and say, "I was at that one" – a digital analogue to the classic concert tee with dates listed on the back. Some artists post photos and set lists from each of their shows, he explained, and even this makes a show feel personal for those who attended. If the set changes slightly each night, this amplifies the effect, as well as keeping things interesting for the performer. Erik felt that these sorts of technologies should allow people to opt out without affecting the others' experience. However, he also expressed concern about giving power to all audience members. Something like a Twitter feed is surely edited. Bands that hand out percussion instruments like tambourines have to deal with participants with no rhythm. Erik provided an anecdote about a band that gave miniature harmonicas to audience members to be played during one part of one song; the crowd continued to play the instruments throughout the whole set and the other bands' sets.

Blake

Blake commented on the importance of context. An experimental performance may only be successful if the crowd is filled with fans of the artist. He felt that a festival-type setting might be more suitable than a small rock club. Blake remarked on the effectiveness of these projects with large audiences. He recounted an experience seeing U2 perform; the stadium lights were extinguished, and the crowd was instructed to hold up their open cellphones, filling the space with an electric glow. While Blake was concerned that the technologies I showed him may border on gimmicky, he admitted that creating a spectacle has become a significant part of performing: "You gotta have something that's more than the music," he said, "You can't be like the Beatles anymore and just record albums and be successful. There has to be an angle." Although Blake admitted the importance of creating a memorable experience for concertgoers, he seemed to lament the current attitude towards live music: "A lot of people are just there to have a good time. And if you can make them have a good time then you're a good musician. It's a little discouraging." He was also wary of the amount of video recording at modern concerts, explaining that something is lost in a recording. "A concert's an experience," he said, "Go and soak it in and remember it and let it sit in your memory."

Christian

Christian admired the way the projects all seem to aim to "unite" the participants; "There's not a lot of times when we feel that we're united," he said. He also remarked on the size of the audience in the examples and wondered if similar effects could be replicated with smaller venues and smaller budgets. Christian speculated that perhaps these technological spectacles are especially useful at large shows because the performers are so distant from audience members. Having played a handful of shows at larger venues, he has dealt with open spaces that dissipate energy and guardrails that divide performer and audience; these technologies could be responses to this divide. When asked about incorporating similar technologies in his own shows, Christian was at first hesitant. He expressed concern about giving up the "rawness" of the performance; technology could take audiences out of the show. He was also wary of giving up control of the show. However, he quickly backed up, noting that "some of the best gigs are when I felt pretty out of control." Giving the audience some control over the lights or even the set list could be appealing, he admitted, although he would not want the crowd dictating the whole structure of the performance. Christian explained that his sets are organized around tension and release; any audience interaction would have to keep the overall flow of the performance in tact. An ideal system would follow a plan while allowing for the spontaneity that will make the show memorable. Overall, Christian had no reservations about tech-enabled shows. "It's a natural evolution," he explained; technology has always helped to move rock music forward. "That's why I love rock and roll... There's no rules."

3.3 Analysis

A few general conclusions can be made from the questionnaire results that are particularly relevant to my research question. It is encouraging to confirm that most participants are not quietly standing still at live performances; they are cheering, moving, and singing along. A surprising find was that, given the chance to say anything to their favourite artist on stage, most participants would choose simple messages of praise or thanks – something ostensibly achieved already by applauding. Also intriguing was the relative lack of interest in influencing lights and visualizations. Instead, the majority of participants showed great interest in choosing the set list for the performance. Regardless, it is clear that most respondents have little to no reservations about being directly involved in a show and doing so with new technologies. Seemingly, this willingness to interact is more common in those who frequently attend performances at smaller venues. Perhaps, then, artists that play to smaller crowds and can offer more direct interactions both on and off stage have fan bases that are more willing to experiment with new interactions.

Chapter 4

Prototyping

4.1 Prototype #1

4.1.1 Motivation

The first prototype served as an initial experiment for investigating how technology might be used to give an audience new means of participating in a performance. My goal was to develop a simple system that featured a single user ‘performing’ – creating some sort of stimulating output. Multiple ‘audience members’ would then be given the ability to collectively contribute to this output in some way, illustrating a slight shift from presentational to participatory. Ultimately, testing the prototype with users would allow me to observe how both the performer and audience members responded to these adjustments to their roles. I also hoped to establish a hardware and software framework upon which future prototypes could be easily built.

While the focus of this thesis is on rock performances, it was decided that recruiting a rock band would not be necessary for this early, small-scale experiment. I felt that a VJ performance would be suitable. VJing is the real-time creation or manipulation of visuals, which are typically projected to accompany music. Thus, the performing user would be controlling projected visuals, and the audience members would be able to manipulate some aspect of them. Having this collective output clearly displayed on one screen would provide

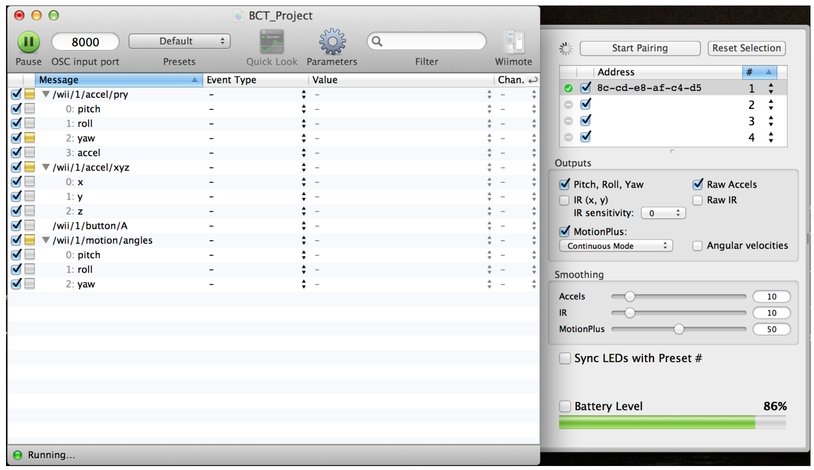


Figure 4.1: OSCulator software receiving data from one Wii controller

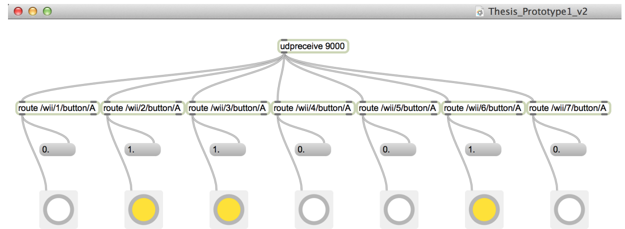
the performer and audience members with clear feedback from their inputs and allow for straightforward observations of their interactions.

Some design concepts were inspired by theory introduced in Chapter 2. The system was modelled after the “core” and “elaboration” roles outlined by Turino (2008). The performer – the core role – would be responsible for keeping the performance on track and have the most influence on the visuals. On the other hand, audience members – elaboration roles – would have less responsibility along with a lesser influence. In explaining presentational and participatory performances, Turino also states that it is not uncommon for a performer to shift between the two forms throughout one performance. To reflect this, I chose to include a feature allowing the performer to effectively ‘mute’ input from the audience and take full control of the output.

4.1.2 Development

The first step in realizing this initial prototype was deciding on the hardware and software that would be used. Wii video game controllers have an abundance of sensors: they contain eleven digital buttons, an infrared sensor, an accelerometer, and a gyroscope (in the newer Wii Remote Plus models), and all of this data can be sent wirelessly to a receiver via Bluetooth. In addition to these affordances, due to the console’s popularity, the Wii controller

(a) Wii controllers



(b) Max patcher: The LED objects turn yellow when the A button is pressed on their assigned controller

Figure 4.2: Testing simultaneous input from seven Wii controllers

is also something that many people have already used before. With these considerations, I decided that the Wii controller was a suitable input device for my experiment. For my purposes, the easiest way to process the controllers' data was using a combination of two software packages – OSCulator[1] and Max[2]. OSCulator allows for communication between devices and audio or video software using the Open Sound Control (OSC) protocol[3]. Fortunately, this software is also specifically designed to communicate with the Wii controller. It can display live data from each sensor as well as activate the controller's LEDs and rumble motor. The data can then be sent to Max, a visual programming environment that is especially useful for handling multimedia. Countless objects can be incorporated into a Max program (called a 'patcher') to manipulate numbers, audio signals, and video clips. Max is commonly used by musicians and video artists to create highly customized and interactive programs.

Syncing the Wii controller with OSCulator was simple, and I was immediately able to view movement and push-button data from my controller (see Figure 4.1). Next, I tested the limit of how many Wii controllers would be able to connect to my computer

[1] `http://www.osculator.net`
[2] `http://cycling74.com`
[3] `http://opensoundcontrol.org`

(a) Black and white

(b) Colour

Figure 4.3: Stills from the two clips used in the prototype

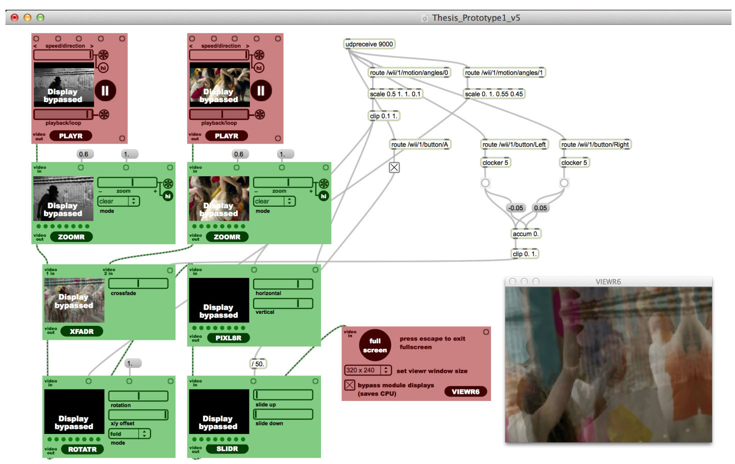


Figure 4.4: Wii controller VJ system

using the current setup. Since my thesis aims to give every member of an audience a new way to participate, this number would ideally be limitless. With Bluetooth technology, unfortunately, one master device (my computer) can only connect to a maximum of seven slave devices (Wii controllers). However, for the purposes of this prototype, I felt that seven controllers would be acceptable. A Max patcher was created to display push-button data from multiple Wii controllers. All seven were synced with no issues, and the program worked as expected (see Figure 4.2).

My next task was to create the VJ system. After experimenting with a multitude of video effects objects in Max, I created a basic program. The system is built around two short video loops that can be mixed together and modified. Users can crossfade between the two videos using the controller's Left and Right buttons. The resulting image can be rotated by rotating the controller sideways. Pixelation can be increased or decreased by increasing or decreasing the controller's incline. Finally, holding and releasing the A button enables and disables a motion blur effect. An important part of programming this patcher was mapping controller input to the effects controls. Values had to be carefully scaled and clipped in order for users' movements to translate naturally to the effect they control. I also carefully selected the source video such that the effects of users' actions would be clear; a black and white clip of one person dancing and a colour clip of multiple people dancing seemed to offer sufficient contrast (see Figure 4.3). The resultant patcher is pictured in Figure 4.4.

With the details of the performance in place, the next step was selecting which aspect would be controlled by the audience. It seemed most straightforward to give them control over the crossfader effect. This presents audience members with a simple binary decision – do you want to see more of the black and white video or the colour video? By pressing and holding the Left or Right buttons on their controllers, users can effectively vote on which dominates the screen. In this case, if more people are holding the Left button than the Right, the black and white video will gradually become more prominent than the coloured video. Thus, while the performer retains precise control over multiple combinable effects (rotation, pixelation, motion blur), the collective audience can progressively alter the tone of the visuals. This reflects Turino's (2008) core and elaboration roles, respectively.

The last feature of this VJ system reflects another of Turino's (2008) assertions – that performers often shift between presentational and participatory performance. In response to this, I provided the performing user with a mute function. By pressing the controller's B button, the performer can disable the audience members' controllers, moving control of the crossfader from the audience to the performer. The B button is essentially an on/off switch for audience participation.

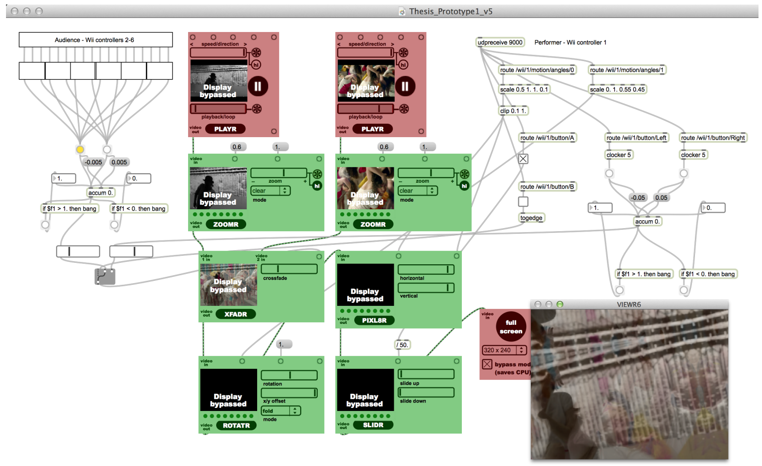


Figure 4.5: Prototype #1 Max patcher

The completed first prototype is illustrated in Figure 4.5, in the form of both a diagram and the final Max patcher.

4.1.3 Testing

Testing was conducted one time with a small group at a research colloquium. I observed user behaviour and received feedback from attendees. The participants were seven OCADU students. The experiment only lasted a few minutes. I explained the concept and controls. The performer had no problem using his controls to make interesting visual output. One participant led the group in first fading all the way to one video then all the way to the other. Nothing broke, and the group successfully made decisions and carried them collaboratively. The performer's mute button worked.

Context is important; experiments should be run at rock shows or in similar environments. Observers commented on the importance of feedback. They asked if this sort of system should be goal oriented; if not, would the users somehow turn it into a game anyways? They considered the task of representing every individual. Will every single audience member be able to interact? What happens to those who are not included? They referenced 'the wave' – there's a flow, a rhythm; the outcome is greater than the sum of its parts; participants know when it's their turn to input...

4.1.4 Analysis

4.2 Prototype #2

This chapter covers the development of the second prototype. I explain the design goals, the creation process, and the user testing that was carried out. The chapter closes with a discussion on the significance of the prototype.

4.2.1 Motivation

This prototype's purpose was to explore possible input mechanisms for audience members. Through user testing, I hoped to identify which were intuitive, which were most natural and meaningful to perform as a group, and which afforded accurate collaborative control. From the start, it was clear that body movement would be more a fitting input than something like button pressing. Users find movement-based interactions more satisfying (Ulyate & Biancardi, 2001); furthermore, there are apparent subconscious ties that link music and movement (Jourdain, 1997; Levitin, 2006), making this a natural form of input for a live music environment. In designing their audience-interaction system, Barkhuus and Jorgensen (2008) found that movements based on already-present behaviour were especially effective input methods. Inspired by this recommendation, I created a list of common crowd behaviours to be incorporated in the system – giving a thumbs up or thumbs down, swaying one's arms back and forth, clapping, doing 'the wave' (also known as 'the Mexican wave'), holding a lighter in the air, and dancing. Researchers emphasize the importance of meaningful feedback in crowd-controlled systems (Ulyate & Biancardi, 2001; Barkhuus & Jorgensen, 2008), and this was also a recurring concern in the response to Prototype #1. Thus, this prototype also allowed for exploration of different feedback methods. After receiving the opportunity to participate in an exhibition at OCAD University, I decided to design this prototype as an interactive installation. By inviting the exhibition attendees to test the various methods of input, I could observe the behaviours of a wide variety of users.

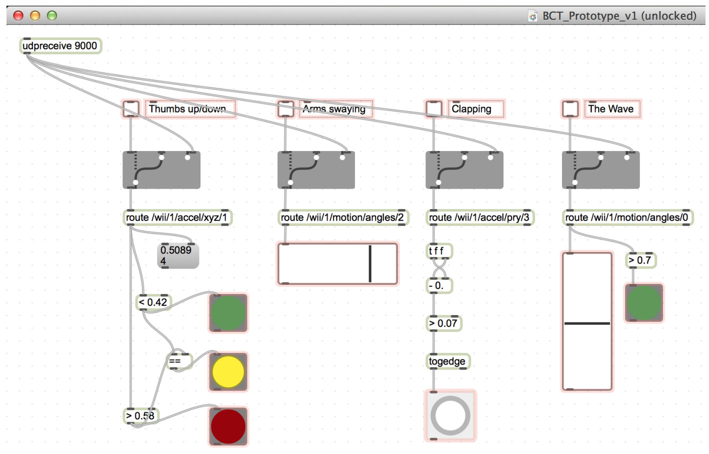
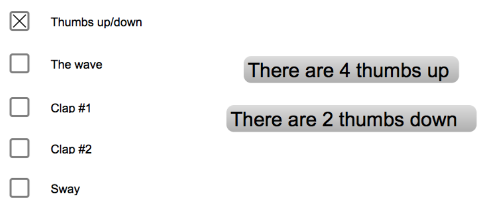


Figure 4.6: Monitoring thumbs up/down, arm swaying, clapping, and the wave

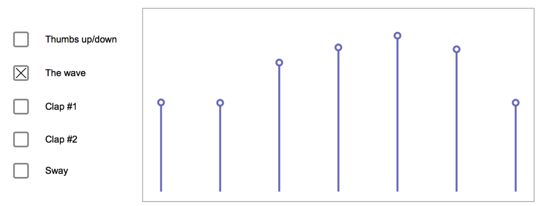
4.2.2 Development

The first prototype provided a suitable framework for this experiment: I continued using multiple Wii controllers as input devices, and OSCulator was used to route the data to Max where it processed and represented visually. From here, I needed to be able to recognize when a user was performing one of the selected crowd behaviours. By pulling data from the controller's motion sensors, I was able to identify when the user was giving a thumbs up or down, swaying their arms left or right, clapping, or doing the wave. I incorporated simple visual feedback – LED objects that light up when the user holds their thumb up or down or claps, sliders that follow arm movement when the user is swaying or doing the wave. Calibrating these required trial and error tests using different thresholds – determining what amount of acceleration qualified as a clap, for instance. Figure 4.6 shows the first iteration of this prototype.

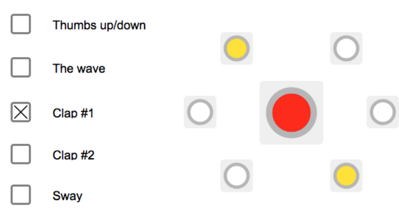
Next, I modularized the previous patcher and multiplied it sevenfold. The actions of seven users could now be monitored simultaneously. I developed new visualizations to reflect these multiple inputs, shown in Figure 4.7. Thumbs up/down mode simply displays how many users are holding their thumbs up and down. The wave mode shows the vertical position of each user's arms. I created two modes to detect clapping. The first displays seven LED objects that illuminate when each user claps, encouraging users to clap in sync.



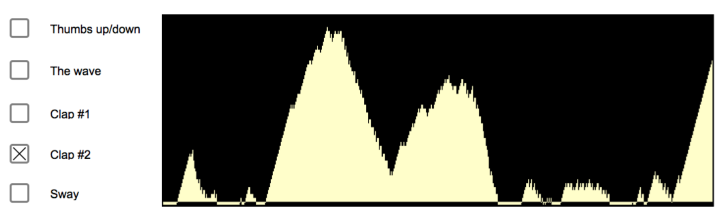
(a) Thumbs up/down



(b) The wave



(c) Clapping



(d) Clap-o-meter

(e) Arm swaying

Figure 4.7: Input methods

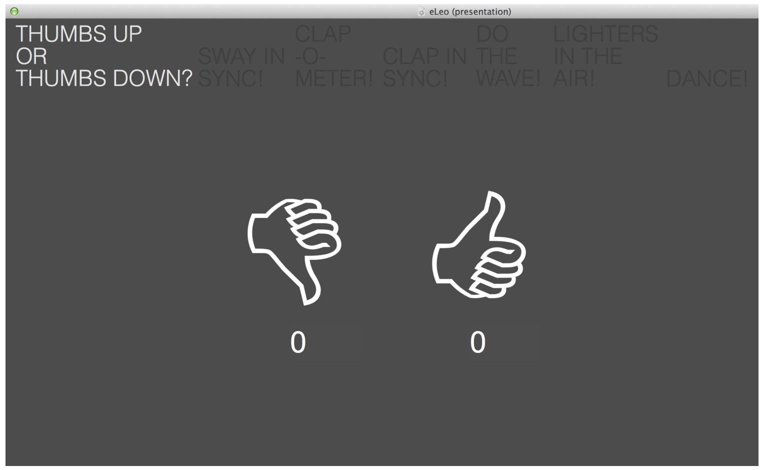


Figure 4.8: Input prompts

The second serves as a 'clap-o-meter,' visualizing the collective clapping activity. Lastly, the swaying mode includes a slider to display the left-right movement of each user.

Two additional modes were added at this point to act as controls. The first invites users to imitate holding a lighter in the air. This is done by holding the Wii controller upright and pressing the A button, causing LED objects on the screen to illuminate. I included this button-based input to observed how user response compared to that of a motion-based input. In the final mode, users are simply told to dance. The visuals displayed on screen are generated randomly; the users are not actually controlling anything. This was included to see how users responded when the effect of their actions was not clear.

In preparation for the exhibition, I modified the patcher to function as an installation. An auto-play function was implemented; the input methods are looped through automatically, each activated for ten seconds at a time. A short text prompt is displayed to give users a hint at what action they should be performing ("Thumbs up or thumbs down?" "Sway in sync!" "Clap-o-meter!" "Clap in sync!" "Do the wave!" "Lighters in the air!" "Dance!") as shown in Figure 4.8. Thus, the system would not require an operator, and users could approach it at any time during the exhibition and test each mechanic.

Lastly, in an effort to make the installation more compelling, part of the VJ system from Prototype #1 was added to the patcher. Namely, the crossfade system was implemented

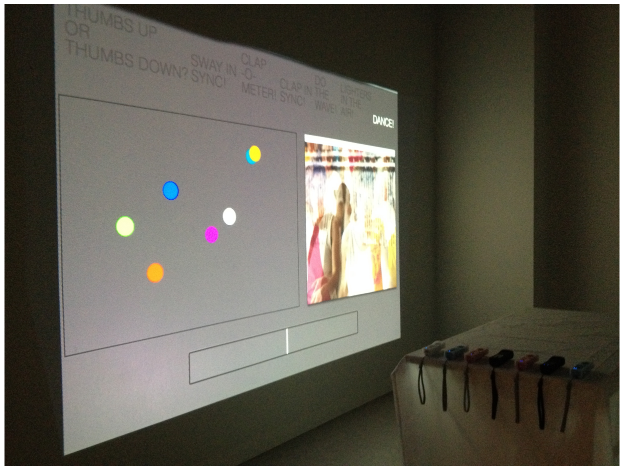


Figure 4.9: Prototype # 2 installed at the exhibition

and connected to each input mechanism. For instance, in swaying mode, if all users swayed their arms to the right, the slider would move to the right and the colour video loop would overtake the black and white loop. In addition to the representative visual feedback already established, then, users could also see how their collective inputs could be used to control a separate system.

4.2.3 Testing

Testing took place during the opening night of the exhibition. The final patcher was projected on a large wall in a darkened room using a short-throw projector. The seven Wii controllers were laid on a table in the middle of the room, their LEDs illuminated, inviting users to pick them up. Figure 4.9 shows the prototype set up in the exhibition.

Given the casual nature of the event, attendees were relaxed and generally openminded. Groups that entered the room were asked if they were interested in participating in an experiment. Those that accepted were briefed in one of two ways. Half of the groups were told the experiment's motivation – that I was investigating how audience behaviours could be turned into inputs at live music events. The other half were given no information. I did this to see how users would approach the system if they were given no context. Indeed, some of those who received no information were unsure what was expected of them. Some began pressing buttons on their Wii controller, sometimes holding it up and pointing it at the screen. One user wondered aloud what their goal was.

Those who were given context understood the system much more easily, quickly figuring out that they were to perform physical motions as a group to manipulate the video. Some users invited bystanders to grab a controller and join them, eager to test the system's capabilities. Each input mechanism received different reactions. As I observed and spoke with participants, some general opinions of each method began to surface.

Most understood the action quickly, experimenting with combinations. Some tilted the controller left to right, not fully inverting it for thumbs down. The up-versus-down counter seemed random to them at first. Some started shaking the controller. Eventually users coordinated all thumbs up or all thumbs down. Users commented that the thumbs down motion was difficult to perform. Users commented that the up/down action seemed strange to link to the left/right movement of the crossfader slider.

Users had trouble identifying which slider was theirs. Some solved this by shaking the controller violently and observing which slider was moving accordingly. Some users were holding the controller backwards, causing their input to be reversed and adding confusion. Groups eventually coordinated themselves and began swaying in sync. Most users did not raise their arms in the air, instead casually hold the controller in front of them. In conversation, they indicated that they did not feel compelled to since the visuals were already responding.

Since the visualization reacted gradually, users were initially confused. They commented on the slow response. While some said that the visualization was appealing, many agreed that they would preferring seeing individual Groups eventually worked together to fill up the clap-o-meter. Users were unsure how to clap with the controller in their hand; some complained that it was painful to hit it against their palm. Users tired of this mode quickly.

In most groups, one user would lead the others by counting out a time. Users commented that it was a fun challenge to try to clap in sync. However, once syncopation was achieved, most groups felt they had achieved what was expected and stopped. Some commented that

Figure 4.10: Three users experiment with the prototype

the minor lag in the visualization was distracting.

Nearly all users instantly understood the prompt and were eager to raise their arms in the air. Figure 4.10 shows three participants performing the wave input. One group did not communicate and instead just watched their own slider, but most cooperated to raise their arms simultaneously. One group organized themselves in a row such that they were in the same order as their sliders on screen. Users enjoyed the appearance of this visualization. Although, a particularly thought-provoking comment was made by one user: this visual representation of the wave was less appealing than the wave itself.

Most users instantly understood this as well. Some tried to see if pushing the button rapidly would create a different response. Some groups worked together to light up all the LED objects together. This seemed unexciting to users; one vocalized her boredom.

Most users responded to the prompt without hesitation and began moving. Others were clearly not comfortable doing so. Many stared at the random visualizations and tried to make sense of their role. Some were annoyed when told their input had no effect.

In multiple modes, users noted that they were not paying attention to the video and were rather focusing their attention on the sliders or LED objects. One user suggested that if the system were incorporated into a live performance, the video clips could be two different live feeds of the performance itself.

4.2.4 Analysis

4.3 Prototype #3

This chapter covers the development of the third and final prototype. I explain the design goals, the creation process, and the user testing that was carried out. The chapter closes with a discussion on the significance of the prototype.

4.3.1 Motivation

The final prototype took the form of a collaboration with one of the ethnography subjects, local musician Christian Hansen. After our interview, he expressed interest in incorporating one of my prototypes into a performance. My ethnographic study made it clear that each performer has a unique opinion on what makes a great performance; thus, I knew that it would be important to develop a new prototype with Christian and ensure that the system reflected his performance style.

The current incarnation of the Christian Hansen band features Christian providing lead vocals and Molly playing keyboard, performing backup vocals, and controlling backing tracks. Both bring high energies to their performances; Christian frequently moves around the stage, dances, and sings very expressively, and Molly, despite being stationed behind a keyboard stand, continuously moves to the music as well. The band does not typically use any more equipment than is needed. They aim to make a big impact through simplicity and rawness. As explained in Chapter 5, Christian will often involve the audience, encouraging singalongs and moving between the stage and the crowd. He feels that it is his job to maximize the audience's energy level.

The band expressed interest in allowing the audience to control their light show in some way. Christian wanted a system that could unite audience members without turning into a distraction from the music. He also expressed concern about giving the audience too much control; only the band should be able to dictate the flow of the performance. Christian hoped that the technology would create a controlled environment that left some room for

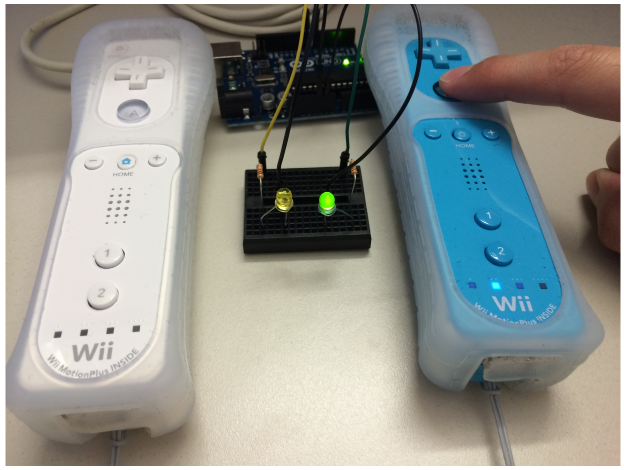


Figure 4.11: Turning on an LED with a Wii controller using Maxuino

some spontaneity and uncertainty.

My goal, then, was to develop a system that satisfied these wishes...

4.3.2 Development

I decided to give each audience member control over one light in an array of lights to be located on stage. An audience members would receive a simple wireless device to control their light, which would provide obvious and consistent visual feedback. Users would only be faced with two options – turn the light on momentarily or leave it off. As the last prototype revealed, limiting the audience's options in this way would reduce the opportunities for confusion; this feature also reflects the artist's desire for simplicity. This one-light/one-person mechanic had additional benefits. If a user decided not to participate, for instance, it would not have a direct effect on the other users' experiences. The system is not inherently goal oriented, so a user is free to experiment without concern for what the others are doing. That being said, there could be benefits to collaboration; for example, if the crowd worked together to turn on all of the lights in sync, the outcome would likely be more rewarding than if everyone acted independently. Organizing synchronized inputs proved to be enjoyable for participants in the previous experiment.

The prototype was built off of the reliable framework used in the previous experiments.

Figure 4.12: Testing different types of lights

Audience members would be given Wii controllers, and OSCulator and Max would process the data they generate. In order to operate lights, however, I also needed to make use of an Arduino microcontroller. This compact and versatile board could be easily programmed to operate an array of lights. After installing a library called Maxuino[4], I was able to easily send instructions to the Arduino from the Max environment. As an initial test, I pulled button-press data from one Wii controller and connected the Arduino to an LED; I was successfully able to illuminate the LED by pressing the controller's A button, as shown in Figure 4.11.

Next, I tested three different light bulbs – two incandescent bulbs with different power ratings and one amber LED bulb (see Figure 4.12). Both incandescent bulbs, once turned on, provided a great deal of brightness; however, the high current draw and slow turn-on time made them undesirable overall. The LED bulb, on the other hand, turned on and off instantly, and it became sufficiently bright while only drawing around 80 mA. This bulb was clearly most suitable for the prototype.

Due to the relatively small current supplied by the microcontroller, the LED bulbs had to be controlled using a relay circuit – that is, one where the high-power bulbs could be controlled by lower-power signals. A power adapter was used to supply the current, while

[4] `http://www.maxuino.org`

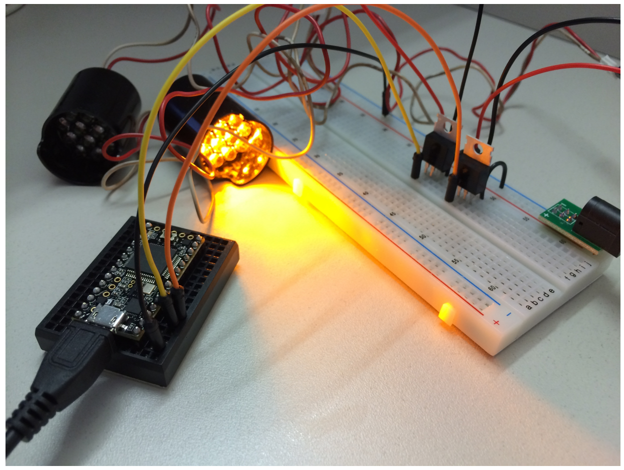
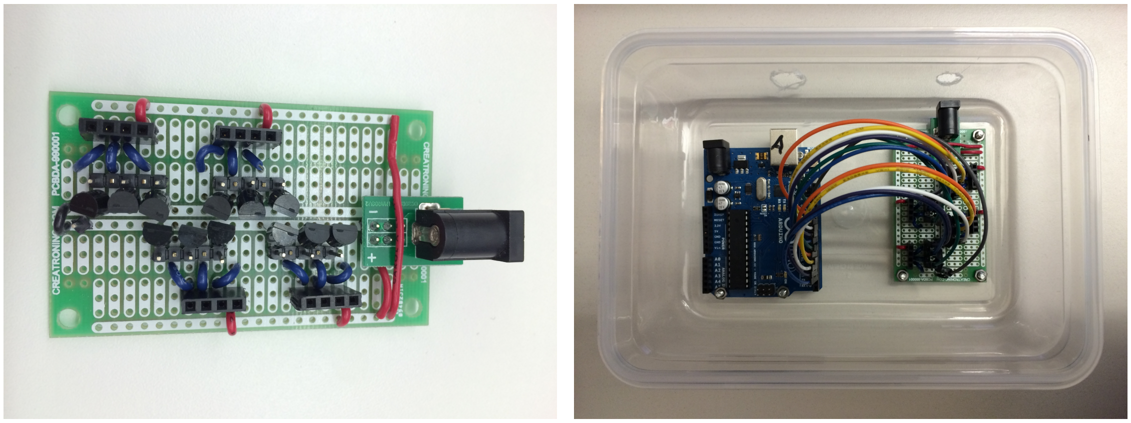


Figure 4.13: Operating two lamps using transistors and Arduino

transistors were used to control its flow. Figure 4.13 shows this setup with two bulbs. Two Arduino pins controlled two transistors, thereby allowing each bulb to be turned on and off independently. By incorporating Maxuino, I was able to activate each bulb using a Wii controller.

While previous prototypes were limited to seven users, I felt that, to have a proper impact in a real concert setting, this experiment needed more participants. Since one computer can only connect to seven Wii controllers, the most straightforward solution was to use two computers. With OSCulator open on the second computer, I was able to send the controller data it received to the first computer by creating a local network. With this, I could also control the LEDs on all controllers from one computer. Thus, the maximum number of users grew to fourteen.

Now that the primary hardware and its limitations had been established, the system could be designed with greater detail. I wanted the lights to be spread across the stage, but it was important that users could quickly identify which bulb was in their control. The Wii controller provided a solution – namely, its four LEDs. If the lights were divided into four sections installed uniformly across the stage, a controller could indicate which section contained its paired light by illuminating the corresponding LED. A controller with the third LED illuminated, for instance, tells the user that they control a light in the third section of



(a) LED control board

(b) Project box

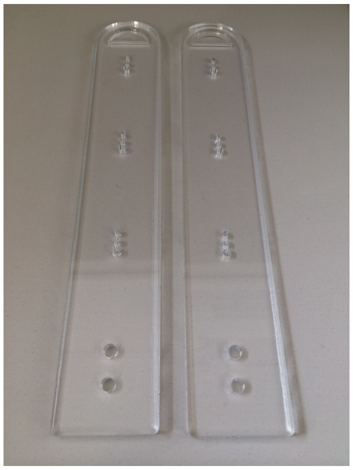
Figure 4.14: Electronics

the stage. Thus, to evenly distribute the lights, it was decided to place three bulbs in each section, fixing the number of users at twelve. Figure X illustrates this concept.

A compact circuit board was next assembled to handle the control of each bulb. The board had to contain a barrel jack for the power supply and connectors for twelve light bulbs. Smaller transistors were selected to minimize board size. Figure 4.14(a) shows the outcome. Finally, the board was installed in a plastic project box alongside the Arduino to ensure all connections remained secure while the system is in use (see Figure 4.14(b)).

Simple lamps were designed to house the bulbs; four would hold three bulbs each. I decided to use acrylic, a relatively durable and accessible material that could be quickly laser cut with my design. A first version of the lamp was cut in quarter-inch-thick acrylic to ensure measurements were correct. After making some adjustments, the lamps pictured in Figure 4.15 were created. A hole was placed at the top of each lamp so that they could be easily tied to or hung from something on stage. Lastly, each lamp was connected to about fifteen feet of wire, ending in a connector that plugs in to the circuit board's connectors.

Next, a Max patcher was created to pull data from all twelve Wii controllers and control all twelve lights. But how exactly would a user turn on their light? It was decided that the bulbs would be activated by performing a clapping motion with the controller. Out of

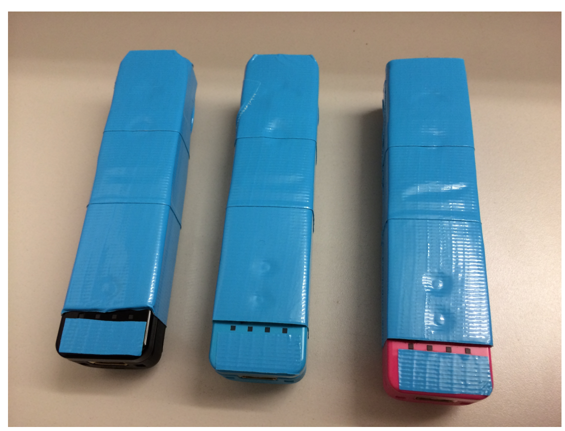


(a) Laser-cut design

(b) Light bulbs and wire installed

Figure 4.15: Acrylic lamps

(a) Controller with foam cover



(b) Taped controllers

Figure 4.16: Preparing the Wii controllers

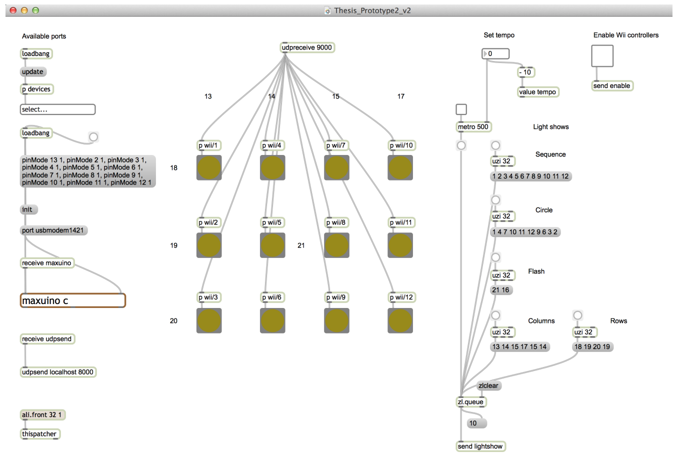


Figure 4.17: Control and monitoring in Max

the methods tested with the last prototype, I felt that this made the most sense with the system: simply clap your controller against your palm to momentarily illuminate your light. This input method was generally well received by users of the previous prototype, but it received some criticisms. For instance, users felt the visuals did not respond quickly enough to their claps; a quick test with the LED bulbs indicated that such latency would not be an issue here. Some Prototype #2 users also noted discomfort when performing the clapping motion. To address this, a foam cover was added to the Wii controllers, and they were wrapped in tape (see Figure 4.16). This also solved another problem that emerged in the previous experiment. Some users were distracted by the controller's buttons; by covering the buttons, users would not presume that they served a function.

At this point, discussion with Christian and Molly led to an important question – how long will audience members be controlling these lights? The band and I both felt that the system should not be active for the whole performance; if it caused any unexpected problems, it would be best to not have this affect the entire show. We agreed to introduce the controllers before the band's last two songs. This would give the crowd sufficient time to warm up to the band and serve as a surprising finale. Rather than leaving the lights inactive before this, however, I offered to program a light show to accompany the first part of the performance. Figure 4.17 shows the Max interface that was designed to control and monitor

Figure 4.18: The Silver Dollar Room

the lights' activity. For the first part of the show I could activate preprogrammed lighting patterns, and for the second part I could activate the controllers and observe audience inputs.

Final adjustments were required to make the system as responsive as possible. This included selecting the threshold for which input values qualified as claps, determining how long a light would remain on for one flash, and fine-tuning a delay to avoid one clap resulting in two consecutive light flashes. As a guide, I tested the values by clapping to the beat of one of Christian Hansen's high-tempo recordings; the values were set when I could do this without the lights flashing too quickly or too slowly.

4.3.3 Testing

The prototype was tested at The Silver Dollar Room, a two-hundred-capacity bar located in downtown Toronto (see Figure 4.18). The event took place on a Saturday evening, with Christian Hansen as the headlining act and four other bands on the bill. Christian was scheduled to play for twenty minutes. By the time the band started, the crowd was between twenty and thirty people; Christian guessed that only a fraction of the audience was familiar with his band. The atmosphere was relaxed, most people standing and watching the performers, some with a drink in hand.

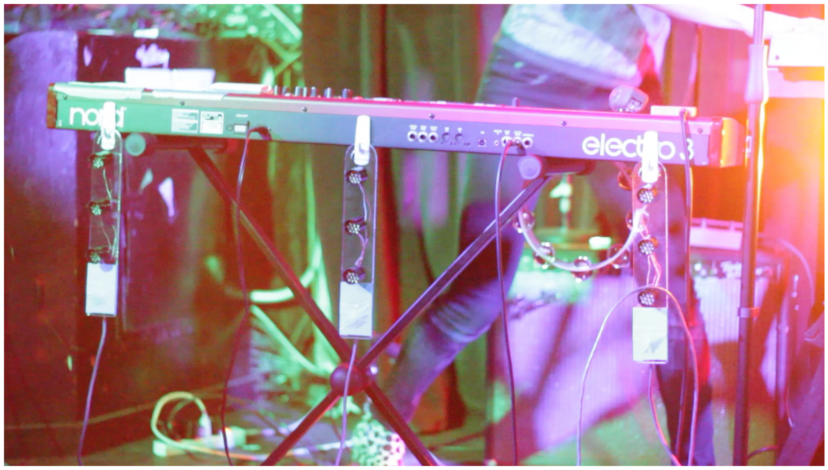


Figure 4.19: Hanging lamps

Due to the number of artists performing, the changeover between sets had to be quick. It was decided that hanging the lights from the keyboard would allow for the simplest setup. Temporary hooks were attached to the keyboard, and the lamps were hung as pictured in Figure 4.19. This positioning made the lights sufficiently visible to the crowd. The lamps were plugged in, the Max patcher activated, and the lights all quickly tested in time for the band to begin.

During the performance, I was stationed in a booth directly beside the stage, giving me a clear view of the performers and most audience members. This allowed me to make first-hand observations of the users during the event. Three cameras were also stationed throughout the room to provide video documentation for later reference.

The Performance

The performance lasted roughly twenty minutes. For the first part of the show, I was activating preprogrammed lighting patterns, adjusting the speed of the flashing such that it matched the tempo of the song. This worked well; the colour and brightness of the lights suited the environment. Figure 4.20 shows the band performing with the light show.

With two songs remaining on the set list, Christian announced to the crowd that they were about to run an experiment, announcing, “We’re going to pass control of the lights over

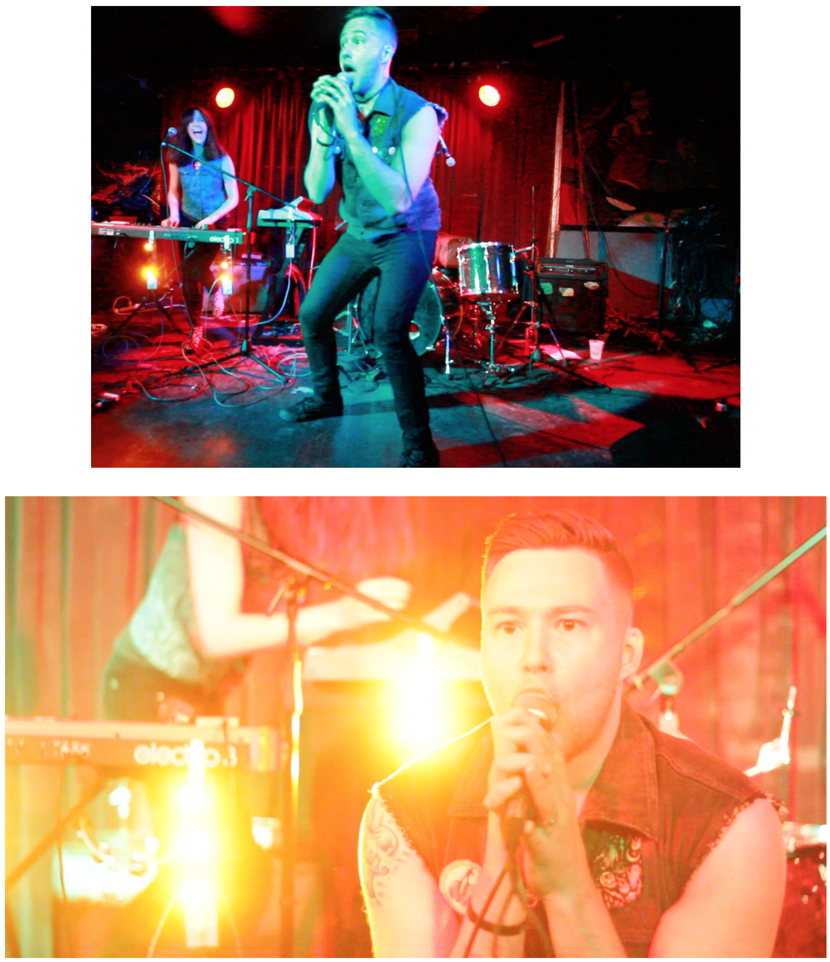


Figure 4.20: The lights flash as Christian Hansen performs

Figure 4.21: Audience members move with the controllers

to you." Many attendees appeared amused and intrigued. Molly stepped off stage and began passing out Wii controllers to the audience members nearest to the stage. Nobody seemed to hesitate to grab a device. As the participants inspected their controllers, Christian provided a basic explanation of the system. He encouraged users to "go nuts, get busy, improvise." As users received their controllers, they began clapping, shaking, and flicking the devices and watching the lights react. The lamps flickered erratically. This process of dispersing the controllers and explaining the system took approximately one minute; by the time Christian's explanation was complete, the lamps' flickering had slowed down. Users seemed to understand the concept, and, presumably, most if not all had identified their light. Without wasting any more time, the band launched into their penultimate song "Please Don't Do That" – a relatively mellow track, but one with a catchy and consistent beat. The house lights were lowered, and the lamps came to life as users started moving to the music.

As has been the case with the previous prototypes, the manners in which users handled the devices were surprising. Most held the device as a Wii controller is typically held, the thicker weighted end in their palm; a few others had it flipped upside down. To turn on their light, these users tended to perform a flicking motion – as if using a whip or drum stick. One person, in fact, appeared to be 'air drumming' to the beat with both hands. Some other users were dancing carelessly, moving their device in all sorts of directions at varying speeds. It was unclear how these motions were influencing the lights, but the users did not seem to be paying much attention to the lights. Most surprisingly, there were two participants that held the device from its center, grasping it with the tips of their fingers. One of these people was shaking the device like a shaker instrument for the majority of the performance, and the other was flicking the controller and sometimes twisting it about its center. Notably, there were no users consistently performing a clapping motion with their device. While the energy of the crowd was high overall, there were a couple of participants who remained quite still and activated their lights sparingly. Figure 4.21 shows four audience members using the controllers.

Audience members also varied in how closely they watched the lights reacting. Initially, of course, users looked closely at the lamps to identify their light. Once this was sorted out, approximately half the users could be observed staring at the lights for portions of the performance; the rest resumed watching the band.

While all participants were moving their controllers along with the music, they were not generally moving in sync with each other. This is because, while some users were activating their light steadily to the beat of the song, others were drumming along with its more complex rhythms. Thus, many of the lights were not flashing at the same time, but most were following the rhythm of the song. The resulting light show, then, appeared random at times but also had moments of cohesion.

As the performance neared its end, it took a surprising turn. Molly took advantage of a vocal-centric part of the song, stepping out from behind her keyboard and pulling two of the lamps off of their hooks. She held them high above her head and shone them on the audience before turning and lighting up Christian's profile. Molly then handed one lamp to her bandmate, and Christian held it in front of himself as he sang the song's closing chorus, the audience-controlled lights illuminating his face. Figure 4.22 captures some of these moments.

For the last song of the set, Christian Hansen performed their most popular song "Co-

Figure 4.22: Christian and Molly interact with the crowd-controlled lamps

caine Trade." This upbeat track kept the audience moving, and nearly all of the lights continued flashing through the end of the song and into the final applause.

Audience Feedback

After the performance ended, users returned their device to the table from which I was overseeing the show. Every participant provided a positive comment to me as they handed over their controller ("That was awesome," "That worked really well"). I spoke briefly to two of the users afterwards to get some more information. Both were in good spirits and did not have any criticisms to offer. They indicated that the system was easy to understand and comfortable to use, and they believed that they knew which light they were in control of. One of the participants who was dancing especially hard explained that it was the band's energy that motivated him to move energetically as well. Interestingly, this person also indicated that this was his first time seeing the band perform; in fact, he had not heard of the band before that night.

Performer Feedback

I met with Christian one week after the performance, giving him and Molly time to reflect on and discuss the experiment. First, I asked for his overall impressions on the event.

He saw the technology as an opportunity for something new and exciting to happen. It was "an added bonus" to their performance.

"It was a pretty easy setup. It worked on stage," he said. He said that he would like if the lamps had their own stands and could be set up on either side of the stage. He expressed interest in having some of the lights able to attach to his microphone and being able to swing the lights around his head. He and Molly had begun thinking about how, logistically, they could tour with it and adapt it to different venues. They are used to traveling lightly.

He felt that the lamps were most effective when the house lights were kept low.

He felt that it did not take long for users to understand the technology: "A minute into the song it was apparent that they knew what they were doing." However, he wondered if the connection could be made more clear – perhaps making the output more "visually significant" or using less lights.

He felt that the audience was clearly enjoying the interaction. "They were engaged with it, but it would be cool to see? how can the payoff be even bigger for them?" He suggested that the colour of the lights could change in some meaningful way. He noted that just being at a concert is satisfying enough for some people.

He noted that the show had a "medium" turnout, and the crowd was a mix of people both familiar and unfamiliar with the band. Different types of shows are handled differently: "I feel the difference." There are times when it feels right to ask the crowd to participate and times when it does not. If the crowd is onboard, "you can ask a lot of them and they?ll go with you to wherever you want to go." He noted that people like options.

He was particularly fond of the moments when the band members were holding the lamps in their hands: "It just facilitated something totally new that we've never done before and changed the vibe of the show for sure." He said that using the lights mostly felt natural but for a moment that the band was giving them too much attention: "You don?t want it to become about the light. You want it to be a marriage between this awesome light and your face and the music and the whole vibe and story and feeling that it creates." He indicated that the potential randomness of the flashing lights was not a distraction: "I was ready for that." He said that he only would have been distracted if something malfunctioned.

He thought that introducing the devices for the last two songs was a good choice. He noted that it makes sense that this was our instinct. Giving people control for an entire performance would probably not work out: "I don?t know if you can expect that much of people." He felt some users were ignoring the lights by the end of the show. He suggested that the rules of the interaction could change periodically throughout the show – in the same way the mood of the lighting changes in the preprogrammed light shows of major productions. "For maximum impact? everything should support the story of the show." The lights could be in the band's control for some parts, in the audience's control for others, or sometimes off altogether; some signal could indicate when things change. The lights could also be moved to different parts of the stage throughout the performance. The band could effectively "write the script" for how the lights behave.

4.3.4 Analysis

Chapter 5

Conclusion

5.1 Discussion

5.2 Future Directions

5.3 Conclusion

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Appendix A

Research Ethics Board Materials

Research Participant Consent Form

Date: **MM/DD/YYYY**
Project Title: **Interactive Technology For An Enhanced Live Music Performance**

Principal Student Investigator:
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INVITATION
You are invited to participate in a study that involves research. The purpose of this study is to investigate how audience members might use simple technologies to communicate with performers during a live music performance.

WHAT'S INVOLVED
As a participant, you will be asked to interact with the technology provided to you in various ways. After the experiment, a brief interview will be conducted in which you will be asked about your experience. The experiment will be roughly twenty minutes long, and the interview should take no more than ten minutes.

POTENTIAL BENEFITS AND RISKS
Benefits of participation include helping to shape future versions of this technology and potentially contributing to the field of music/performance technology. There are no known or anticipated risks associated with participation in this study.

CONFIDENTIALITY
All information you provide is considered confidential; personal identifiers will not be included or in any other way associated with the data collected in the study. Data collected during this study will be stored electronically and password protected. Data will be kept until the conclusion of the project in April 2014 after which time it will be deleted. Until then, access to this data will be restricted to the Principal Student Investigator Ryan Maksymic and the Faculty Supervisor Adam Tindale.

VOLUNTARY PARTICIPATION
Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. You may decide to withdraw from this study at any time without penalty, and all data collected up to that point will be discarded. Quotations from interviews will not be attributed to you without your permission.

PUBLICATION OF RESULTS
Results of this study may be published in reports, professional and scholarly journals, students theses, and/or presentations to conferences and colloquia. In any publication, data will be presented in aggregate forms.

FEEDBACK
If you are interested, you may choose to provide your email address, and information on the results of the study will be sent out at its conclusion. Only one brief email will be sent; you will not be spammed, added to a mailing list, etc.

CONTACT INFORMATION AND ETHICS CLEARANCE
If you have any questions about this study or require further information, please contact the Principal Student Investigator Ryan Maksymic or the Faculty Supervisor Adam Tindale using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at OCAD University [file number: OCADU 127]. If you have any comments or concerns, please contact the Research Ethics Office through jburns@ocadu.ca.

CONSENT FORM

I agree to participate in this study described above. I have made this decision based on the information I have read in this Research Participant Consent Form. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

Name: ____

Signature: ___________________________ Date: ___________________________

☐ Yes, I wish to be attributed for my contribution to this research study. You may use my name alongside statements and/or quotations that you have collected from me.

☐ Yes, I would like to hear about the outcome of the study upon its completion:

Email: ____

Thank you for your assistance in this project. Please keep a copy of this form for your records.

Research Ethics Board

September 16, 2013

Dear Ryan Maksymic,

RE: OCADU 127, "Interactive Technology for an Enhanced Live Music Performance."

The OCAD University Research Ethics Board has reviewed the above-named submission. The protocol and the consent form dated September 16, 2013 are approved for use for the next 12 months. If the study is expected to continue beyond the expiry date (September 16, 2014) you are responsible for ensuring the study receives re-approval. Your final approval number is **2013-33.**

Before proceeding with your project, compliance with other required University approvals/certifications, institutional requirements, or governmental authorizations may be required. It is your responsibility to ensure that the ethical guidelines and approvals of those facilities or institutions are obtained and filed with the OCAD U REB prior to the initiation of any research.

If, during the course of the research, there are any serious adverse events, changes in the approved protocol or consent form or any new information that must be considered with respect to the study, these should be brought to the immediate attention of the Board.

The REB must also be notified of the completion or termination of this study and a final report provided. The template is attached.

Best wishes for the successful completion of your project.

Yours sincerely,

Tony Kerr, Chair, OCAD U Research Ethics Board

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