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 it is less often employed to encourage participation from audience members. This thesis investigates how digital technologies might be used to make rock concerts more participatory. An ethnographic study was first carried out, surveying concertgoers and musicians to identify current attitudes towards audience participation and technology-enabled events. Prototypes were developed and tested to assess new methods for facilitating audience involvement. The final prototype was created in collaboration with a local band and implemented during a live performance; both the audience and performers found the experience enjoyable. Upon analysis, several characteristics for a successful participatory technology were identified. Limiting constraints on user inputs and promoting true interactivity between audience and performer yielded the best results. It was concluded that digital technology provides new opportunities for audiences to participate in music performances.

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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 grow 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 are growing more technically complex and spectacular all the time. Powerful equipment makes shows louder, larger, and flashier. Only recently, however, have artists and researchers begun investigating how

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

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. A performance by an orchestra might be considered purely presentational, for instance; musicians on an elevated stage perform rehearsed works to a silent and attentive crowd. Participatory performances, on the other hand, involve only participants and potential participants, and there is no artist-audience distinction. Peruvian communities, for example, perform in large groups with each participant dancing or playing a wind instrument.

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 settle lawsuits (Jourdain, 1997) – it is most widely regarded as a relationship-forming social activity (Levitin, 2006; Turner, 2011). It is only in the past 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, public performances established a strict divide between performer and audience; musicians dressed alike and performed composed and rehearsed pieces while audience members politely listened.

While today's popular music concerts are more relaxed, the divide between performer and audience is still prominent. Furthermore, performances today are in some ways more presentational than ever with a variety of additional stimuli being blasted at audiences. Giant screens display dynamic visuals and extreme closeups of performers, and heavy-duty mechatronics are incorporated to continually 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 – and by the music video in particular. Many concertgoers might 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 relatively 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 alongside them. In rock music, the barrier between the audience and the performer is often 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. Rather than flowing from performer to audience, information can now move freely between the two parties.

This level of connectivity is beginning to be embraced offline and even during performances. Popular artists like Coldplay, Usher, and Arcade Fire have experimented with new ways of using technology to make their audiences an integral part of their concerts. The modern technologies that make this possible are also piquing the interests of human-computer interaction researchers, who have recently started investigating how crowd-based interfaces for interactive systems might be best designed. Now, more than ever, those who were once only spectators might have the ability to become meaningful participants.

1.2 Purpose

This thesis investigates how rock performances might be made more participatory using digital technology. The research questions take the form of a design problem, asking how each component of a participatory system might be conceived such that both audience members and performers are satisfied and the overall live music experience is enhanced. What type of output do audience members want to influence? How might a system capture inputs from a large group of users in the context of a rock concert? What sort of feedback can simply but effectively inform users that they are in fact making contributions to the performance? How involved do rock musicians actually want their audiences to be?

To address these questions, multiple participatory technologies were created through a user-centred design process. An initial exploratory phase took the form of an ethnographic study. In order to understanding the cultural phenomena surrounding rock performances, both music fans and artists were surveyed. Using an online questionnaire, frequent concert-goers were asked about their feelings towards participating in performances. Next, thorough semi-structured interviews with three experienced musicians provided me with performers' perspectives on audience-performer interaction and the use of new technologies at concerts. The results of these studies then informed the conceptualization of three prototypes – three different interactive systems that were tested with users. Providing especially significant data was the final prototype, which was created in collaboration with a local band and tested at a real performance. By observing and interviewing both the audience members and performers, I was able to begin forming responses to my research questions.

1.3 Scope and Limitations

The breadth of the research completed was regulated in the interest of practicality. Only rock music performances, for instance, are considered herein. In the context of this work, 'rock music' refers primarily to Western rock and roll music, but it could easily also include the pop, punk, hip hop, and folk genres. The fundamental requirement was that the music is performed in an environment where audience and performer roles are clearly defined but where audience members feel comfortable being active participants. This thesis does not, for example, consider implementing participatory technologies at classical music recitals. Financial matters were also generally disregarded. The market viability of the prototypes are not discussed in this work.

There are uncontrollable factors that limited the reach of this thesis as well. While much of the existing work that is referenced involves large-scale events, this research could only realistically deal with relatively small audiences and venues. Additionally, due to geographical limitations, user testing was only completed in the city of Toronto; thus, perspectives from other communities are not represented in this work.

1.4 Overview

The remainder of the document is organized as follows:

Chapter 2: Literature Review

An overview of the history of music and performance is provided, and presentational and participatory performances are contrasted. I examine how presentational performance has grown into what it is today and how rock music and modern technologies are bringing participation back into live music. A survey of related research includes work in crowd-based interfaces and audience-performer interaction. Lastly, I present case studies of existing participatory technologies.

Chapter 3: Research Approach

The primary and secondary research questions are listed and justified. I describe the research methods that were implemented and explain why they are appropriate tools.

Chapter 4: Ethnography

An ethnographic study was conducted, including an online questionnaire for concertgoers and semi-structured interviews with musicians. The results of these surveys are presented and analyzed.

Chapter 5: Prototyping

I describe the production of three interactive systems that were developed in order to address the research questions. Each prototype was tested with users, and the findings were analyzed. The final prototype was created in collaboration with a local band and tested at a live performance.

Chapter 6: Conclusion

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

Chapter 2

Literature Review

This chapter presents the historical significance of this research and outlines related work that has been completed by both researchers and performers.

2.1 Background

In this section, music's significance as a social activity among humans is investigated. The concepts of participatory and presentational performances are explained and contrasted. I discuss the rise of presentational performance and how it turned into a visual spectacle. Lastly, I consider rock music and detail the emerging participatory culture.

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 personal 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, music is everywhere: performed in stadiums or on street corners, scoring film and television, and being shared on the Internet.

How did music become such a significant human activity? 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. While music may be primarily a source of pleasure and entertainment in Western societies today, it still serves valuable social functions. 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 within groups 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; participants can momentarily forget reality and feel one with those around them. Anthropologist Edith Turner echoes this idea, referring to a phenomenon called "communitas." She explains, "Communitas 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 that music is its most reliable source. 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 directly responds 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 slightly 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 newcomers 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 "wide tuning" 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 (Turino, 2008). A performance by an orchestra is a good example: professional musicians on a stage perform composed and rehearsed songs to an attentive audience whose 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; a performer 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, and this productization of music has been present since presentational performances began gaining popularity just centuries ago.

2.1.3 Presentational Performance, Technology, and Visual Culture

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 concerts were gradually becoming more abundant and 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. Similar technologies are being used in even more abstract ways by groups like Gorillaz – an alternative rock band fronted by fictional characters. The group's live performances often feature real musicians silhouetted by projections of the animated 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 artificial performers indicates the influence technology has had on live performance. Compelling visual elements are becoming increasingly essential in modern concerts.

So why are visuals such an important part of today's 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, began replicating music videos. As Music Television (MTV) reached the height of its popularity in the 80s and 90s, the music video became the "the primary musical text," a role previously held by the sound recording. Thus, while concerts used to serve to authenticate an artist's musical ability, they now also had to authenticate their image and charisma as portrayed in their music videos. 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 the dance moves that they had seen on television – never noticing, or perhaps never caring, that he was lip-synching the vocals throughout. As television became the primary source for music, live performance had to respond by becoming more visual.

2.1.4 Rock Concerts 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, here the audience is only 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).

While rock concerts can be extremely presentational, fortunately they can also simultaneously challenge the inequality that has been established between audience and performer; they are 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. 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 a part of the performance. Elvis Costello has toured with a "Wheel of Songs," for instance, inviting audience members to spin the large wheel and determine which tune the band will play next. The Flaming Lips give a handful of audience members ridiculous costumes and let them dance behind the band for entire con-

[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`

certs. Green Day, performing for 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 more and more ordinary, and they reflect music's increasingly participatory culture.

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 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 messages 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 users to post comments as they listen to a song, praising or critiquing certain parts of the track. With crowdsourcing services like Kickstarter, artists can 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

[3] http://soundcloud.com

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

[5] http://blend.io

to request songs for specific tour dates on their website. Many music festivals make use of social media, displaying messages or photos shared by audience members on big screens around the festival grounds. Some artists even share photos from their own performances. Toronto band Born Ruffians, for instance, takes photos of their fans from on stage and posts them 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 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 of their shows. Video recording, meanwhile, has become a contemporary version of this practice. Fans film parts 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.

The above examples are indeed providing new ways for audience members to participate in live music performances. However, in most cases, the actual participation is occurring either before or after the performance itself. The next section details work by researchers and artists that are exploring new methods of audience participation *during* performances.

2.2 Related Work

This section explores research done on crowd-based interfaces and the facilitation of audience-performer interaction. Also presented are case studies of projects that were implemented at large-scale events with popular music artists.

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

2.2.1 Crowd-Based Interfaces

Designing for large groups of people has only recently attracted notable interest in the field of human-computer interaction (HCI). The recent ubiquity of public displays, networked personal devices, and location- and movement-tracking technology is allowing for new possibilities in this area, Brown et al. (2009) explain. These researchers emphasize that designers must take into account not only individual user experiences, but the experience that will emerge from a large assembly of users. Furthermore, there are many different types of crowds to consider. 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 HCI-focused research investigates different methods for giving a crowd of people control over a system. The contexts vary from interactive dance clubs to multiplayer games to scoring systems for sporting events.

Ulyate and Bianciardi

Ulyate and Biancardi's 2001 paper describes the Interactive Dance Club, a venue that they designed which delivers audio and visual output based on inputs from multiple participants. The goals of the project were to create coherent 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, modulate music loops, and manipulate projected video and computer graphics. 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 noises. 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 allowed an audience seated in a theatre to control an on-screen game. The first method tracked the audience as they leaned their bodies left and right; the control mechanism was intuitive, but the system required frequent calibration. The second method followed the shadow of a bouncing 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. The authors suggest that the control mechanism should be obvious or audience members will quickly lose interest. They 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 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) formulated a 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 that Feldmeier and Paradiso developed) 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. To evaluate this concept, a group of users were walked through a hypothetical scenario with paper prototypes. Users embraced the idea but doubted it would actually be effective in accurately representing a crowd's opinion. The authors acknowledged this, maintaining that the devices could still serve to enhance the spectator experience.

2.2.2 Audience-Performer Interaction

There are additional considerations when a crowd-controlled system is based around a performance. For instance, performers can enhance an audience's experience by acting as a "compere," inviting spectators to participate and providing instructions on how to do so (O'Hara, 2008). However, they also serve as a point of focus for audiences; incorporating an interactive system into a performance could incite a fight for the crowd's attention. This section details research that investigates how an interactive system might be incorporated into a live performance.

Bongers

Bert Bongers (2000) provides a theoretical HCI framework for interaction between performers, audience members, and electronic systems in a musical performance. He defines "performer-system-audience" interactions as groups of control systems wherein events are either control or feedback processes. Electronic 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 at a time. A real performer-system-audience environment called "The Interactorium" is described. This featured a performer playing an experimental electronic instrument. Audience members' chairs were equipped with vibration motors and pressure sensors. The audience's movements in their chairs would trigger visuals projected on stage that were then interpreted by the performer. Bongers here makes a notable distinction between "reaction" and real "interaction" in this context:

> Real interaction is a living two-way process of giving, receiving and giving back. In a traditional performance set up the audience is passive, the performer active. The increasing use of "audience participation" in a traditional concert setting acknowledges the need but does not address the issue in any depth - typically the situation created is one of "reaction" not "interaction". A situation can be created where the audience and performer meet, each influencing the other, as if conversing, while maintaining the quality of the performance at a high level (p. 49).

Freeman

Glimmer is a research project by Jason Freeman (2005) that allows an audience to shape the sound of music being played by a live orchestra. Taking inspiration from analogue participatory performances and crowd-based video games, Freeman developed a "continuous interactive feedback loop" using coloured lights and computer vision software. Audience members were given battery-operated light sticks that they could turn off and on. Cameras captured the audience and analyzed light activity. Coloured lights in front of each musician instructed them how to play. The more lights that were illuminated in the crowd, the faster the musicians were instructed to play. The audience was divided into groups, each connected to three or four musicians. Groups were rewarded for being active participants; if their lights were frequently turned on and off, the corresponding musicians were given more complex instructions. An onstage screen provided visual feedback to the crowd, displaying coloured rectangles to represent each group's activity. Freeman reported that, in general, users were engaged in the performance. While the system responded to the light sticks turning on and off, he found that most users preferred keeping their lights illuminated at all times. Some users were frustrated that their input did not seem to be influencing the system. Freeman concludes, "Large-audience participatory works cannot promise instant gratification: giving each person a critical role; requiring no degree of experience, skill, or talent; and creating a unified result which satisfies everyone" (p. 4).

Gates, Subramanian, and Gutwin

Gates et al. (2006) investigated the complex interactions between DJs and audience members in nightclubs and how technology might better facilitate them. The authors gathered their information by observing behaviours at nightclubs, surveying DJs, and 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. 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 DJs' 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

In their 2008 paper, Barkhuus and Jørgensen investigate 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. Researchers observed 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.

Tseng et al.

This paper from 2012 describes the motivation and creative process behind an 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 iOS app. Audience members downloaded the app before the show and entered a code corresponding with 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 on stage. 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 iOS device, although one of these spectators maintained that she enjoyed the show even while being excluded from the interaction.

2.2.3 Case Studies

Some popular artists have experimented with incorporating participatory technologies into their performances. The following projects deal with both audio and visual output, a range of audience sizes, and varying genres of music.

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 was activated when it connected to the Wi-Fi network at the performance, and various modes were enabled as the show progressed. "Konsole" mode displayed live performance information such as the tempo and names of the tracks being played. "Kamera" provided a live video stream of the performer's perspective. "Synkotik" displayed visuals that were synchronized with on-stage visuals. Lastly, "Logikal" allowed users to rearrange audio samples using their touch screen, influencing 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 rock group Kasabian bring audience members into their performances by making their faces part of the stage show during their 2011 tour[9]. Cameras captured video of the audience, and face-tracking software identified individual audience members. Graphics were then applied to the footage, highlighting the tracked faces and drawing lines between them. The resulting video was projected on the backdrop behind the band. Upon seeing their faces on the large screen, most audience members became excited and began engaging with the camera.

[7] http://telecircus.com/yeold/Side/Dcuckoo
[8] http://hexler.net/software/synk
[9] http://nanikawa.com/projects/kasabian-tour-2011-interactives

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. All user-submitted content was screened by producers to ensure it was suitable to display.

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 using the DMX512 digital communication protocol. 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 using a MIDI controller or an iOS application. Previous PixMob objects include balls, wristbands, pendants, and beads, and custom object creation is available as well. Past clients include Microsoft, Eurovision, Heineken, and Arcade Fire (as described in Chapter 1).

Wham City Lights

Wham City Lights is a smartphone application that allows multiple device screens 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. Light shows can be created live or programmed in advance using an online editor. The concept was originally developed by US musician Dan Deacon. His intention was to prevent concertgoers from using their personal devices

[10] http://www.momentfactory.com/en/project/stage/Amex_Unstaged:_Usher
[11] http://pixmob.com
[12] http://whamcitylights.com

and disengaging during live performances. Organizations like Billboard and Intel have since made use of this technology at their events.

Xylobands

Xylobands are controllable, multicoloured LED wristbands designed to be worn by potentially thousands of users at entertainment events[13]. They are controlled with a radio transmitter. Using accompanying software, operators can turn all of the Xylobands on and off or illuminate only certain colours. The transmitter has a range of around 300 meters. Each wristband contains a small printed circuit board that holds an RF receiver and an 8-bit microcontroller, all powered by small 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].

[13] http://xylobands.com

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

Chapter 3

Research Approach

This chapter presents the primary and secondary research questions to be answered and the rationale behind them. The research design is described, and methods are explained and justified.

3.1 Questions

Primary Question

- How might rock performances be made more participatory using digital technology?

Secondary Questions

- **Experience:** Do participatory technologies actually improve the concert experience for both the audience and performer?
- **Input:** How can inputs from the audience be captured and processed? Which mapping strategies can effectively translate these inputs into an output?
- **Feedback:** How can users be informed that their input has been received and has influenced the system?
- **Output:** How – if at all – do audiences want to contribute to rock performances? How much control do rock musicians feel comfortable giving audience members? What

aspects of a live performance can be reasonably controlled by a large group of people?

3.2 Rationale

These research questions are both culturally and technologically relevant. They also make up a design problem that has not yet been fully addressed by existing research.

As we have seen, performance responds to the culture within which it exists. For many of the world's societies, music is purely participatory, and it can be more functional than entertaining. Presentational performance eventually emerged in the West as a way for the middle class to flaunt their newfound wealth. Live music morphed into a visual spectacle when mass media created a visual culture and MTV made images and recorded sound inseparable. Today, there is a growing participatory culture. Music fans are able to communicate and even collaborate with artists online. A handful of artists are already beginning to welcome this sort of connectivity into their concerts. I believe that live performances will continue to be influenced by this participatory culture, and participatory technologies are one method of exploiting and supporting this trend.

The ubiquity of public displays, connected personal devices, and location-aware technology is making crowd-based interactions increasingly of interest to researchers. Indeed, HCI researchers have only recently begun investigating how systems might be designed for a large assembly of users. In addition to investigating crowd-based interfaces, some researchers have begun asking how these systems might be implemented in a live music environment. There are, however, questions that have not yet been addressed.

This thesis investigates participatory technologies in the context of a rock concert. While there exists a substantial amount of relevant research, the research questions at hand present a design problem that has yet to be explored. Freeman (2005) created a system to allow an audience to influence music, for instance, whereas Tseng et al. (2012) gave users control over projected visuals. What kinds of outputs might rock audiences wish to control? Gates (2006) found that DJs generally have no desire to implement interactive technologies in their performance environments. Could rock musicians feel the same way? Some previous work treated a crowd as a single source of input (Maynes-Aminzade et al., 2002; Barkhuus

& Jørgensen, 2008), while others gave each participant their own controller (Feldmeier & Paradiso, 2007; Tomitsch et al., 2007). Which method is most suitable for a group of rock fans? By exploring the specific context of a live rock performance, this thesis contributes to this growing field of research.

3.3 Methods

Multiple participatory systems were developed in order to explore the research questions. Given the questions' user-centric nature, it naturally followed to implement a user-centred design process. The ISO standard "Human-Centred Design For Interactive Systems" (ISO 9241-210, 2010) outlines some key principles that will ensure a design process is user-centred. These include the following: understanding the context of use – the users, their environment, and the tasks they perform; utilizing iterative processes; and ensuring that users are involved in all design phases. These principles are reflected in the design research methods that were employed – a combination of ethnographic study and prototyping.

3.3.1 Ethnography

Ethnography is a qualitative exploration of cultural phenomena within a community. Rather than surveying a large number of people about a few topics, ethnographers instead obtain a deep understanding of the lifestyles within a small group of people. Common research tools include participant observation, questionnaires, and interviews. This research method originated in anthropology as a means of investigating "the practices, artifacts, sensibilities and ideas that constitute and inform our everyday lives" (Plowman, 2003, p. 30). Such information can be very useful for designers. As Plowman explains, the ways in which people interpret and use products are "deeply cultural activities." In the 1980s, designers began utilizing ethnographic techniques as a means of exploration and concept generation. While true ethnography can involve months or even years of immersion in a culture, design ethnography is typically abbreviated; designers make "time-sampled observations" of potential users (Martin & Hanington, 2012). Because of the small sample size, an important part of ethnography is how the data is interpreted and extrapolated.

As a frequent concertgoer, I have been exposed to a wide variety of live music environments over the past decade. This personal experience has provided me with a significant understanding of audience members' perspectives. However, to dig deeper and explore others' viewpoints, I conducted a survey of music fans. An online questionnaire asked approximately one hundred regular concertgoers about their feelings towards audience participation, interacting with performers, and new technologies. My ethnographic study of performers was more exhaustive. Three experienced musicians were invited to participate in hour-long, semi-structured interviews. Subjects were asked about their backgrounds as performers and how they interact with their audiences; they were also asked to give their opinions on some of the case studies outlined in Chapter 2. These ethnographic studies helped me formulate possible solutions to my research problems, as I began identifying what types of interactions piqued the interests of concertgoers and performers.

3.3.2 Prototyping

Prototypes are tangible artifacts that are used to test a designer's ideas and gauge client and user responses. They can be of varying resolution; paper prototypes may aid with initial concept generation, for example, while more advanced iterations can help designers make final adjustments to near-complete products. By conducting user testing with prototypes, researchers can gauge their "ergonomics, usability, aesthetic response, and emotional resonance" (Martin & Hanington, 2012, p. 74). This process is ideally iterative: a prototype is created, it is tested with users, and their feedback shapes the design of the next version.

Three prototypes were developed and tested for this study. The prototypes' concepts were generated in order to answer the research questions, with certain design decisions influenced by the existing research, the results of the ethnographic study, and feedback from the previous prototypes. User testing was conducted for each iteration. The final prototype was created in collaboration with a local band and tested at one of their performances. By evaluating the reactions of both the performers and audience participants during these small-scale experiments, I was able to begin developing informed answers to the research questions.

Chapter 4

Ethnography

This chapter describes the ethnographic study that was undertaken. I present and analyze the results of an online questionnaire completed by music fans and three semi-structured interviews conducted with musicians.

4.1 Audience Questionnaire

An online questionnaire was created in order to obtain a sample of modern music fans' opinions on interactive performances. The nine-question survey was completed over one week by ninety-nine participants recruited through links posted on several social media websites. The first few questions informed me of what type of concertgoer each participant was – asking how often they attend live music performances, which genre they usually see performed, and the size of the venues they frequent. I also asked how often the participants communicate directly with musicians through their social media presences. Next, the questionnaire focused on concert behaviours. Participants were asked in which actions they typically partake at live music performances; choices included applauding, headbanging, and holding up hand-written signs. They were asked how they might like to participate in a performance and what sort of message they would send their favourite performer if they could. I asked for their thoughts on getting involved in performances and bringing new technologies into concert settings.

The results are informative, though not overly surprising. Most respondents attend shows semi-regularly – one or more per year (46%) or one or more per month (42%). Rock music is the most common genre by far, accounting for 42% of the responses. Venues of small (38%) and medium (39%) sizes are more popular than large arenas (22%). While 47% of participants stated that they sometimes communicate with artists using social media, 36% have never done this. The most popular concert actions are applauding (91%), singing along with the performer (79%), clapping or stomping to the beat (74%), and dancing (62%). The less-common actions include holding up signs (2%) and booing (2%). When asked how they might want to participate in a performance in a new way, 47% said that they would like to choose the songs that are played, while much fewer expressed interest in manipulating visuals and contributing to the music; 27% 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 responses include song requests and suggestions like "Don't bury the vocals" or "More rock, less talk!" Most participants (64%) indicated that they enjoy when performers ask them to participate in a performance – clapping/singing along or call and response, for example – while 22% stated that they are indifferent. Lastly, 59% said they are excited by the idea of bringing new technologies into a live music setting, with 36% indicating indifference. The complete set of results can be found in Appendix B.

Upon deeper analysis of the responses, some correlations were uncovered. There are clear relationships between show-going frequency, typical 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.

4.1.1 Analysis

These results present some possible approaches to addressing the research questions. It is clear, for instance, that most music fans are comfortable moving at live performances; a movement-based input, perhaps similar to Feldmeier and Paradiso's (2007), would not be out of place in this environment. Respondents enjoy clapping and singing along with live music, but, beyond choosing songs which to hear, few are interested in new ways to get involved. Most concertgoers seem satisfied with the current audience-performer relationship. There is, however, a demographic that seems willing to experiment. Music fans who frequent smaller venues are more inclined to participate in performances and more interested in new technologies, and their relatively high social media activity means that they could be considered members of Wikström's (2013) "participatory culture." Thus, while the case studies in Chapter 2 involved big-name bands and large audiences, a small rock club may be the best environment for experimenting with participatory technologies.

4.2 Performer Interviews

In order to obtain performers' perspectives, three musicians were recruited and separately interviewed: Erik Grice, Blake Enemark, and Christian Hansen. These three were selected because I was familiar with their work and felt that they represented three distinct performance styles within the rock genre. The subjects have different backgrounds as performers and experience playing in different parts of North America for a range of audience sizes. They also have different relationships with modern technology. While their opinions are representative of modern rock musicians, it should be kept in mind that the subjects are themselves music fans; thus, they are also sharing their perspectives 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 Interactive Stage Show), 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. The interviews were semi-structured and therefore quite conversational. Each interview lasted approximately one hour.

4.2.1 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 while on tour to over one hundred people at Edmonton shows. Venues are usually small clubs or halls. They have also played acoustic shows at cafes and similar small venues. A typical Fight concert is energetic yet controlled, and audience members can comfortably move to the music.

Blake

Blake Enemark is originally from Victoria, British Columbia. He learned to play guitar as a teenager and started performing cover songs in bands. Blake recorded and toured with his alt-country band Forestry throughout 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, a revered radio station contest. With this group, Blake played to audiences more sizeable and fanatic than he had ever before, culminating in a performance for around two thousand people in Vancouver's Stanley Park. Blake parted ways with We Are The City after one year. He joined folk group Northcote for a Canadian tour before settling down in Toronto and 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 around

Edmonton. He eventually started performing with his now-wife Molly, incorporating drum machines and prerecorded tracks into his work. This marked the formation of Christian Hansen & The Autistics. When Christian was forced to perform alone for one show, he was inspired to put all of his energy into his performance; 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 significant radio play. Christian and Molly moved to Toronto in 2011, shortening their band name to Christian Hansen. They describe their recent music 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.

4.2.2 Interacting With Audiences

Erik

The Fight encourage some forms of participation at their shows. Their lead singer will often walk out and physically touch audience members, looking them in their eyes as he sings. He will invite the crowd to sing or clap along with certain songs. Erik feels 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 an ideal audience matches 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 feels that it is the band's job to keep the audience's attention. They must make decisions based on the venue, the audience, and the length of the set. Stage banter is usually only implemented to convey pertinent information to the crowd.

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 book opening slots for bigger touring bands. At shows, the band hands out cards with links to their social media pages. Erik believes 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," but he does not feel that this is beneficial to the artist.

Blake

Blake is a self-described introvert. While he is technically the leader of his current band, he expressed a preference for playing in the background. Despite being typically shy with audiences, Blake recognizes the significance of even basic audience participation; singing and clapping along can make one feel like a part of the show. Blake 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. He noted, however, that different performers react to audience participation differently. A guitarist in his former band, for instance, would not allow audiences to clap during songs. "There's a fine line," Blake also 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, and it plays a role in how audiences behave.

The internet presence of Blake's current band is "not very good." Blake recently closed his own Facebook account for personal reasons. Despite this, he acknowledged the importance social media can hold for artists: "It's bridging gaps that have never been bridged before." Blake had an especially meaningful experience with the Reddit community; after an anonymous user posted a link to his music, he 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 feels 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 percent, maybe the audience will get to 100 percent." 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 audience members who are singing loudly. He sometimes even leaves the stage and makes physical contact with the crowd if they seem particularly comfortable. At their most recent Edmonton concert, Christian entered the audience and performed his last song unplugged, the crowd surrounding him and singing along. For him, this moment was "amazing, magical." While he acknowledges that every audience is different, Christian feels that getting the audience involved generally increases 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, Christian enjoys interacting with fans in this way.

4.2.3 Participatory Technologies

At this point in the interview, the musicians were shown images and videos of projects that were outlined in Chapter 2: PixMob, Xylobands, Wham City Lights, Kasabian's Interactive Stage Show, Plastikman's SYNK, and Amex Unstaged: Usher.

Erik

Erik responded negatively to the projects that relied on smartphones; he feels that they would be mostly distracting, and he expressed concern about being responsible for people dropping and damaging their devices. Instead, he favoured the work that had other tangible elements, like the PixMob beach balls. Erik feels that every show should be unique. An attendee should be able to go home and say, "I was at that one" – like a souvenir t-shirt with tour 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 feels that these sorts of technologies should allow people to opt out without affecting the others' experiences. However, he also expressed concern about giving power to all audience members. Groups that hand out percussion instruments like tambourines, for instance, have to deal with participants that do not have rhythm. Erik provided an anecdote about a band that gave miniature harmonicas to audience members, to be played during a particular part of one song; the crowd continued to play the instruments throughout the rest of the set and all of the following bands'. Thus, Erik believes that any audience input would ideally be controlled or edited to limit undesirable content.

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 feels 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 a story of seeing U2 perform; the stadium lights were extinguished, and the crowd was instructed to hold up their open cellphones, filling the space with an impressive 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 admires the way the projects all seemed to aim to "unite" the participants: "There are not a lot of times when we feel that we're united." 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; new technologies 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 makes shows memorable. Overall, Christian has 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 are no rules."

4.2.4 Analysis

The subjects all have considerable backgrounds as performers. They have been involved in various types of performances in different venues and for many types of audiences. They all recognized the importance of connecting with fans online and have benefited from doing so. Thus, these are experienced performers who operate within the online participatory culture, making them prime candidates for this study.

A number of themes were present in many of the performers' remarks, and some notable points were brought up. Firstly, all subjects recognized the positive impact that audience involvement can have on the quality of a performance. Erik and Christian specifically mentioned the importance of raising a crowd's energy. Basing a participatory technology on energetic activity could enhance both the audience's and performer's experiences. Each artist also expressed the significance of context. An ideal system would either be designed for a specific type of venue and audience or made adaptive and scalable. It was mentioned that many small venues allow performers to enter the audience and even touch audience members. Perhaps a participatory technology could complement this physical commingling in such venues or emulate it in those where a barrier exists. Blake noted that audience-performer interactions can be especially meaningful for the performer. An effective system should enhance not just the audience's experience but the performer's as well. There were different opinions on the overall purpose of participatory technologies; while Christian focused on their ability to unite a group, Erik was more interested in them serving as unique, lasting souvenirs. Although a souvenir element seems less relevant to the research questions, it has been implemented before (PixMob, Xylobands) and would likely add value for audience members.

Several concerns were raised by the musicians as well. Blake and Christian expressed worry about new technologies distracting the audience; the spectacle could overshadow the music. A participatory technology should be balanced, complementing the performance without drawing the crowd's (or performer's) attention away from the primary output. A balance should also be struck in how much control the audience is given. An operator could be implemented in a system to monitor and even edit audience inputs. Subjects also suggested that audience members should not be forced to participate if they do not wish to. Thus, an ideal technology would be effective even if only a fraction of the audience is participating. Erik was unexcited by the use of smartphones in a participatory technology, citing them as a possible source of distraction; he also noted that users could be prone to dropping and damaging them. Avoiding the use of expensive personal devices would likely lessen some unease in both audience members and performers. Lastly, the subjects spoke about the influence of alcohol at most rock music performances. A system for audience involvement should account for the possibility of intoxicated participants and incorporate necessary safety precautions.

An obvious yet important outcome of this study was the fact that all musicians are different. The subjects all have substantial experience performing, for instance, but their interactions with audiences differ considerably. While all three musicians were openminded about the projects that they were shown, they undoubtedly have contemporaries that would quickly dismiss such technologies. A participatory technology should reflect the performance style of the artist; ideally, a system would be designed in close cooperation with the performer who would be implementing it.

Chapter 5

Prototyping

This chapter describes the development and testing of three prototypes. Following the details of each iteration is an analysis of the primary findings.

5.1 Prototype #1

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. The prototype was designed to be presented and demoed at a research colloquium. Thus, in addition to being able to observe users' responses to the system, discussion would be stimulated amongst attendees as well.

5.1.1 Development

In order to simulate this scenario and avoid having to recruit a rock band for this small experiment, I developed a basic VJ system. 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 manip-

Figure 5.1: Wii controller

ulate some aspect of them. Having the collective output clearly displayed on one screen would provide the performer and audience members with feedback from their inputs and allow for straightforward observations of their interactions.

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 (in the newer Wii Remote Plus models) a gyroscope, 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 is also something that many people have used before. With these considerations, I decided that the Wii controller was a suitable input device for my experiment. Figure 5.1 pictures one of these controllers.

For my purposes, the easiest way to process the Wii 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

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

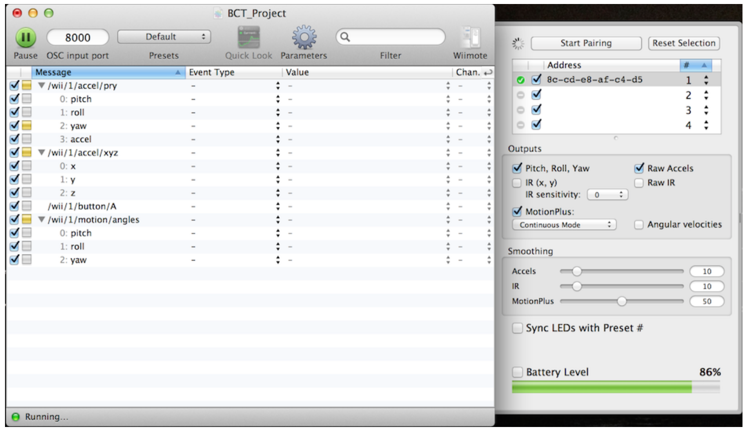
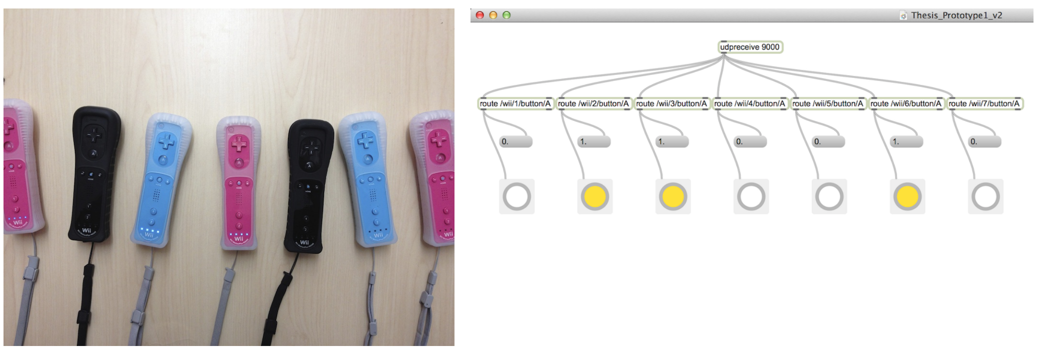


Figure 5.2: OSCulator software receiving data from one Wii controller



(a) Wii controllers

(b) Data successfully received from all controllers

Figure 5.3: Testing simultaneous input from seven Wii controllers

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; for instance, this software was used in Freeman's (2005) *Glimmer* project.

Upon syncing the Wii controller with OSCulator, I was immediately able to view movement and push-button data from my controller (see Figure 5.2). Next, I tested the limit of how many Wii controllers could connect to a computer. 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). While a larger network could be established with some work, for the purposes of this prototype, I felt that seven controllers was sufficient. A Max patcher was created to display push-button data from multiple Wii controllers, and it worked as expected (see Figure 5.3).

My next task was to create the VJ system. After experimenting with a multitude of video effects objects in Max, I created a basic interface. The system is built around two short video loops that can be mixed together and modified. The user 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. A pixelation effect 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 the user's 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 adequate contrast.

With the details of the performance in place, the next step was selecting which aspect would be controlled by the audience. This was informed by Turino's (2008) concept of "core" and "elaboration" roles. In purely participatory performances, he explains, core participants are typically less skilled but work together to keep the performance going; elaboration roles, on the other hand, are reserved for experienced participants adding flourish to the performance. The audience, being the less-skilled party, would assume the core role. It was decided to give them control over the crossfader object – a simple mechanism that can easily be controlled collectively. By pressing and holding the Left or Right buttons on their controllers, users could effectively vote on which video loop dominates the screen. In this case, for instance, if more people are holding the Left button than the Right, the black and white video would gradually become more prominent than the coloured video. Thus, while the audience collectively adjusts the tone of the visuals, the performer retains precise control over the other effects – rotation, pixelation, and motion blur.

The last feature of this VJ system addresses a concern expressed by musicians in the ethnographic study – giving the audience too much control. In response to this, I provided

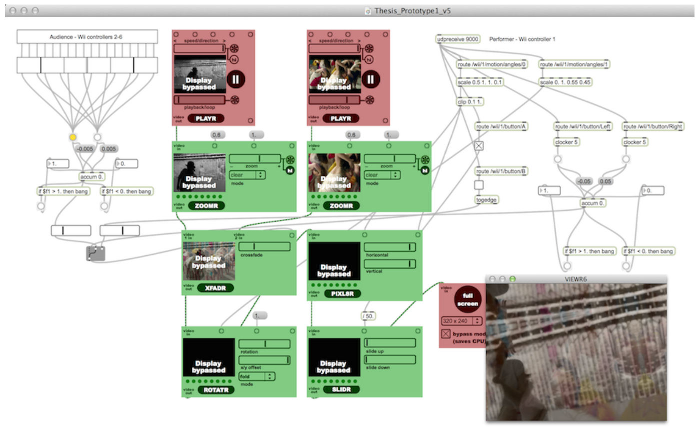


Figure 5.4: Prototype #1 Max patcher

the performing user with a 'mute' function. By pressing their controller's B button, the performer can disable the audience members' controllers, moving control of the crossfader from the audience to the performer. This button is essentially an on/off switch for audience participation.

The completed patcher for the first prototype is shown in Figure 5.4.

5.1.2 Testing

The prototype's concept was presented at a research colloquium, and a group of attendees (students at OCAD University) participated in a brief demonstration. After illustrating the performer's controls, I invited participants to play with the collaborative crossfader mechanism. 'Audience' users had no problems understanding the concept. As soon as users were given their controllers, one participant led the rest in first fading all the way to into one video clip and then all the way into the other. The system functioned as expected, and the group successfully made decisions and carried them out together. Finally, the performer's mute button was introduced, deactivating the participants' controllers to their amusement.

Some initial reactions were collected from colloquium attendees. First, it was suggested that there should be a focus on context; questions would best be answered in a real live music setting. It was asked if this sort of system should be goal oriented; if not, would the users somehow turn it into a game anyways? Several people agreed that some form of direct feedback should be provided to users. One attendee wondered if every audience member could be individually represented, rather than treating the group as a single unit. Discussion led to talking about 'the wave' – where individual participants perform a simple action to create a large, impressive visual effect. It was also asked how my system would react if some audience members did not wish to participate.

5.1.3 Analysis

The willingness of users to participate and the amount of discussion that was sparked confirmed that this research is of interest to the public. This prototype raised many points to be considered for future iterations. For example, it was encouraging to see the users immediately begin collaborating. Facilitating this tendency could make future iterations more intuitive for users. The voting system implemented in this prototype, however, is likely not the best way to promote collaboration. This left-versus-right model could easily create a competitive, goal-oriented environment instead of a performative one. The voting system's many-to-one mapping also presents problems with feedback; the results of each user's actions are combined and thereby obscured. How can future prototypes provide clear, individual feedback while still effectively contributing to the overall performance? Furthermore, how can a system react if only a portion of an audience chooses to participate? One feature that raised no issues was the mute button; it seems sensible that future work should continue allowing performers to regulate audience control.

Further reflection led me to contemplate the nature of the participation. This prototype involved the audience directly influencing a performer's primary creative output – similar to D'CuCKOO's MidiBall or Freeman's (2005) *Glimmer* project. Projects like PixMob or Xylobands, however, are different: while the performance's primary output is live music, the audience is only participating in the light show – what I am calling the secondary output. As emphasized by the ethnographic study, and as is reasonable to assume, the average performer is hesitant about allowing others to influence their primary output. Thus, a participatory technology would likely be more desirable to performers if it was limited to secondary output.

5.2 Prototype #2

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. This prototype also allowed for exploration of different feedback methods. Lastly, by basing it around the voting-based VJ system from Prototype #1, I hoped to make conclusions about goal-oriented systems and the crowd behaviours that result from them. After receiving the opportunity to participate in the eLeo exhibition at OCAD University, it was decided to design this prototype as an interactive installation. By inviting the exhibition attendees to test the various methods of input, I could observe their behaviours and collect reactions from a wide variety of users.

5.2.1 Development

From the start, it was clear that body movement would be a more fitting input than something like button pressing. Most users find movement-based interactions satisfying (Ulyate & Biancardi, 2001); plus, 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 Jørgensen (2008) found that motions based on already-present behaviour were especially effective input methods. I created a list of common crowd behaviours to be incorporated in the prototype – giving a thumbs up or thumbs down, swaying one's arms back and forth, clapping, and doing 'the wave' (also known as 'the Mexican wave').

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 points their thumb up or down

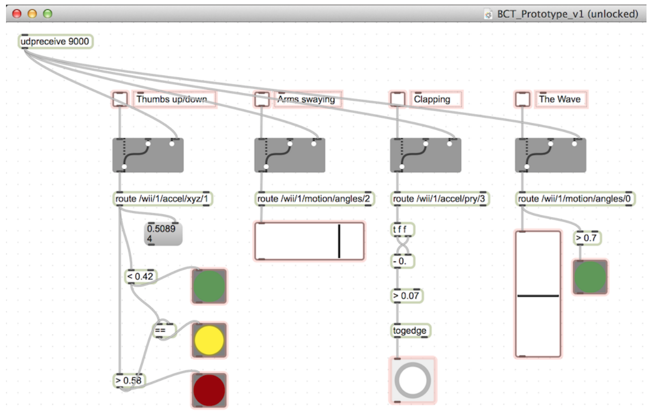
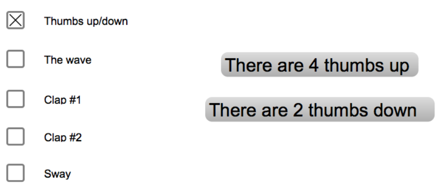


Figure 5.5: Monitoring thumbs up/down, arm swaying, clapping, and the wave

or claps, and 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 5.5 shows the first iteration of this prototype.

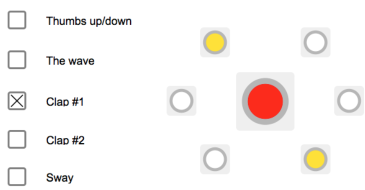
Next, I modularized the patcher and multiplied it sevenfold. The actions of seven users could now be monitored simultaneously. I developed new visualizations to reflect these multiple inputs, shown in Figure 5.6. Thumbs up/down mode simply displays how many users are holding their thumbs up and down. 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. The second mode – a 'clap-o-meter' – was included to compare how users react to collective visualizations compared to the other modes' individual representation. 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 invited 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 completely unclear.

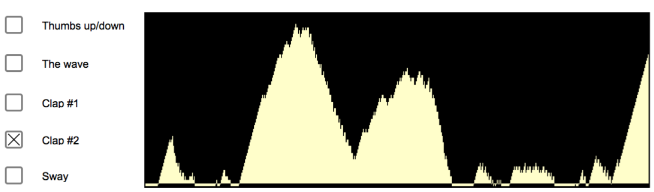


(a) Thumbs up/down

(b) The wave



(c) Clapping



(d) Clap-o-meter

(e) Arm swaying

Figure 5.6: Input methods

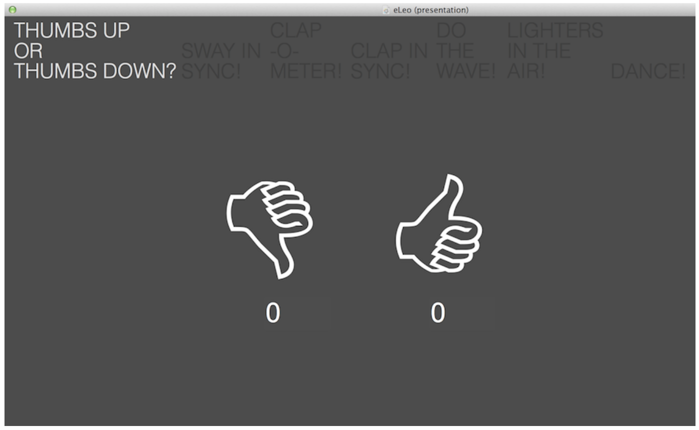


Figure 5.7: Input prompts

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 5.7. Thus, the system would not require an operator, and users could approach it at any time during the exhibition and test each mechanism.

Lastly, part of the VJ system from Prototype #1 was added to the patcher. Namely, the crossfade system was implemented and connected to each input mechanism. For instance, in swaying mode, if all users swayed their arms to the left, the slider would move to the left and the black and white video loop would overtake the colour loop. In clap-in-sync mode, the colour video would play only if users manage to consistently clap together.

5.2.2 Testing

Testing took place over a few hours during the opening night of the eLeo exhibition at OCAD University. 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 5.8 shows the prototype set up in the exhibition. Approximately twenty users engaged in the installation

Figure 5.8: Prototype # 2 installed at the exhibition

for extended amounts of time.

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 with minimum instruction. Indeed, some of those who received no information were unsure of what was expected of them. Some only pressed buttons on their Wii controller, sometimes holding it in front of them 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 could perform physical motions as a group and 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.

Thumbs Up or Down

Most users understood this action quickly. Some tilted the controller left and right, not fully inverting it for a thumbs-down input. Others simply started shaking the controller. The up-versus-down counter seemed random to many users at first. As groups started to understand the system, they coordinated inputs – all thumbs up or all thumbs down. Users commented that the thumbs-down motion was difficult to perform. Some commented that the up/down action seemed strange to link to the left/right movement of the crossfader slider.

Sway in Sync

Users had trouble identifying which slider was connected to their controller. Some solved this by shaking the controller violently and observing which onscreen slider was moving accordingly. Some users were holding the controller backwards, causing their input to be reversed and adding confusion. All groups eventually organized 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 lift their arms since the visuals responded regardless.

Clap-O-Meter

Since this visualization reacted gradually, users were initially confused, and several commented on the slow response. While some said that the visualization was appealing, many agreed that they would preferring seeing individual outputs. Some groups worked together and tried to fill up the clap-o-meter. Some users expressed uncertainty about clapping with the controller in their hand, complaining that it was painful to hit it against their palm. Overall, users seemed to tire of this mode quickly.

Clap in Sync

All users quickly caught on to this mode. In most groups, one participant 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 synchronization was achieved for a few seconds, most groups felt they had completed what was expected and stopped. Some users also commented that the minor lag in the visualization was distracting.

Figure 5.9: Three users experiment with Prototype #2

The Wave

Nearly all users instantly understood this prompt and were eager to raise their arms in the air. Figure 5.9 shows three participants performing the wave input. While one group did not communicate and focused on their own slider, most cooperated to raise their arms simultaneously. One group even organized themselves in a row such that they were in the same order as their corresponding onscreen sliders. Users enjoyed the appearance of this visualization. Although, a particularly thought-provoking comment was made by one user: this electronic representation of the wave was less satisfying than watching the wave itself.

Lighters

Most users instantly understood this input as well. A few 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 mode seemed unexciting to most users; one vocalized her boredom.

Dance

Many users responded to this prompt without hesitation and began moving. Others were clearly not comfortable doing so. Groups expressed confusion over the random visualizations and tried to make sense of their role. When told their input had no effect, some users were slightly annoyed.

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

5.2.3 Analysis

Several revelations came out of this prototype regarding input mechanisms. Inputs based on already-present behaviour were generally intuitive for users. The Wii controllers raised some issues, however; buttons distracted some users, and inputs could not be successfully performed when the device was held in unexpected orientations. Measures should be taken for future prototypes to avoid or adapt to such incorrect use. As the first prototype began to show, modes that rewarded collaboration here received the most immediate responses. However, when users felt that there was a goal, they stopped participating once they believed that it was achieved. The text prompts that were used in this system seemed to place limits on the users and should be excluded in real-world participatory systems.

Testing also provided insight on feedback methods. Individual visualizations for each user, such as the clap-in-sync LEDs or the wave sliders, were most effective. This was reinforced by the fact that most participants did not pay attention to the video output; users wanted to look at their individual influence on the system more than the collective results. Immediate feedback is also crucial; unlike the clap-o-meter, a system should allow users to quickly discover how they can influence it. Lastly, it is important that watching the overall output is more captivating than watching others perform the input itself.

5.3 Prototype #3

The final prototype took the form of a collaboration with one of the ethnography subjects, Toronto 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 in close collaboration 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, controlling backing tracks, and shaking a tambourine. 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, 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 4, Christian often involves the audience in performances, 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 some spontaneity and uncertainty.

My goal, then, was to develop a system that satisfied these wishes while allowing me to make conclusions by observing its impact in an actual live music scenario. How do real audiences react to unfamiliar technologies? How does the system impact real musicians as they perform?

5.3.1 Development

I decided to give each audience member control over one light in an array of lights to be located on stage. An audience member 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-to-one mapping

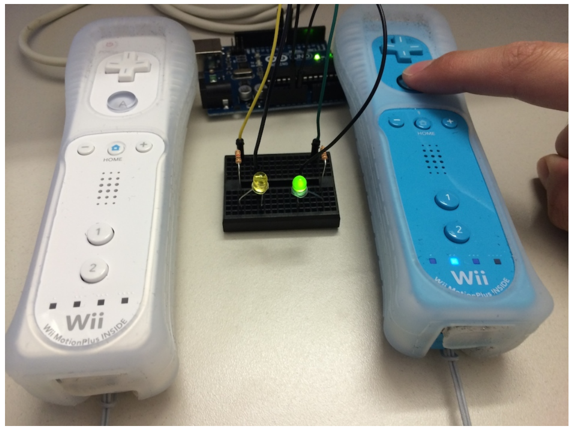


Figure 5.10: Turning on an LED with a Wii controller using Maxuino

would have 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 also 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 impressive 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. 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 control multiple actuators. 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 5.10.

Next, I tested three different light bulbs – two incandescent bulbs with different power ratings and one amber LED bulb (see Figure 5.11). Both incandescent bulbs, once turned on, provided a great deal of brightness; however, the high current draw and slow turn-on

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

Figure 5.11: Testing different types of lights

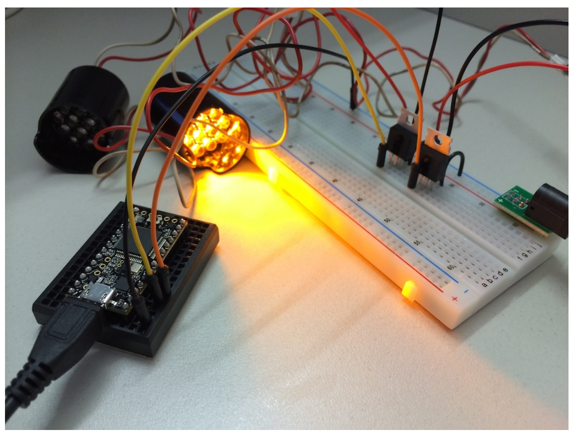


Figure 5.12: Operating two light bulbs using transistors and Arduino

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 higher-power bulbs could be controlled by lower-power signals. A power adapter was used to supply current to the bulbs, while transistors were used to control its flow. Figure 5.12 shows this setup with two lights. Two Arduino pins control 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.

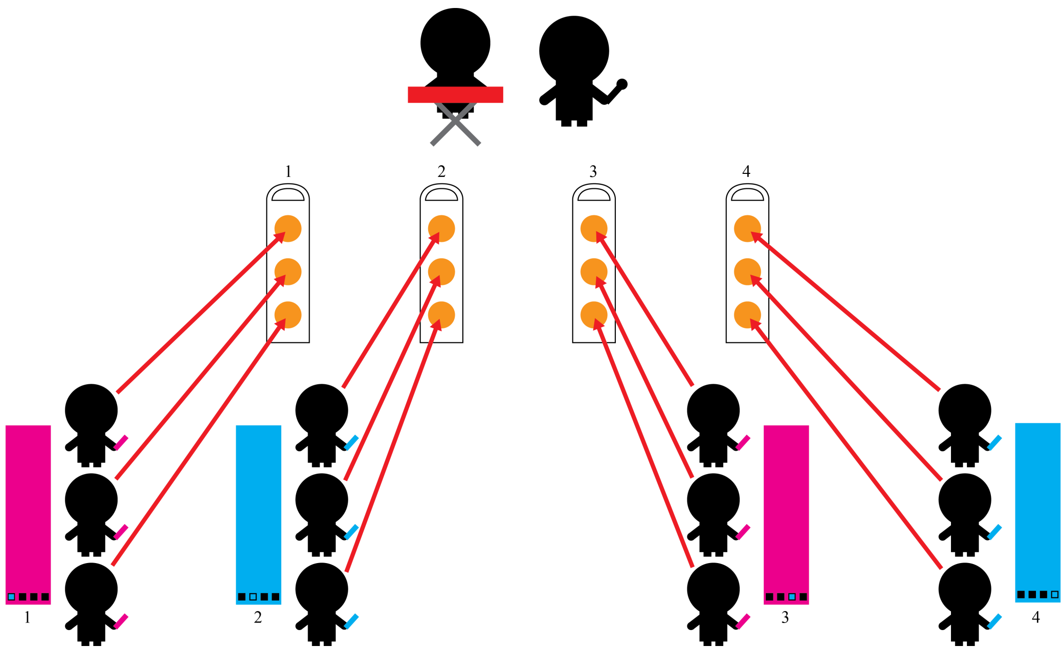
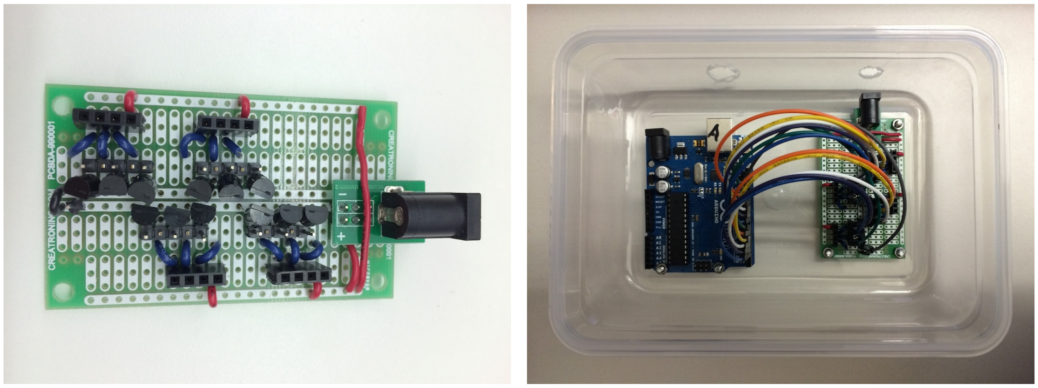


Figure 5.13: Wii controller LEDs indicate each user's corresponding lamp

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 the stage. Thus, to evenly distribute the lights, it was decided to place three bulbs in each



(a) LED control board (b) Project box

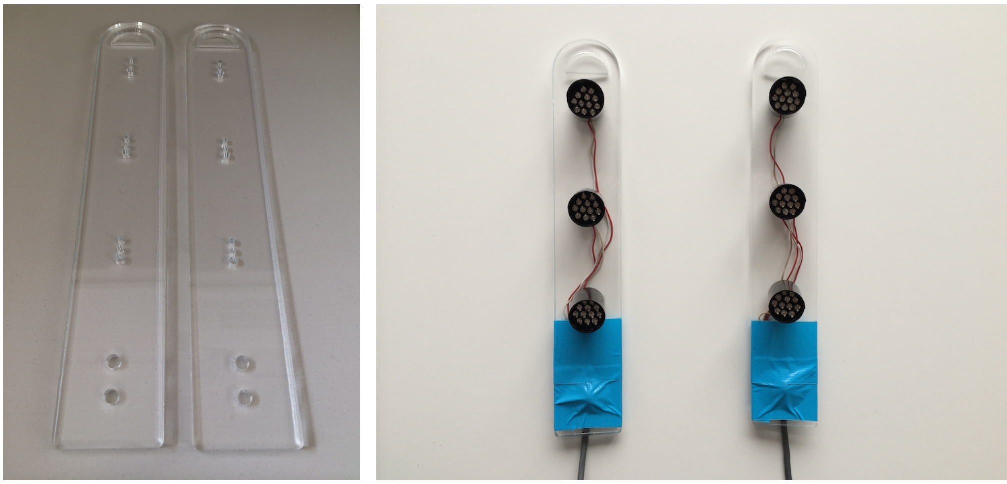
Figure 5.14: Electronics

section, fixing the number of users at twelve. Figure 5.13 further illustrates this setup.

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 5.14(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 was in use; this is shown in Figure 5.14(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 5.15 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 approximately fifteen feet of wire, ending in a connector that plugs in to the circuit board's terminals.

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 the methods tested with the last prototype, I felt that this made the most sense with the



(a) Laser-cut design

(b) Light bulbs and wire installed

Figure 5.15: Acrylic lamps

(a) Controller with foam cover

(b) Taped controllers

Figure 5.16: Preparing the Wii controllers

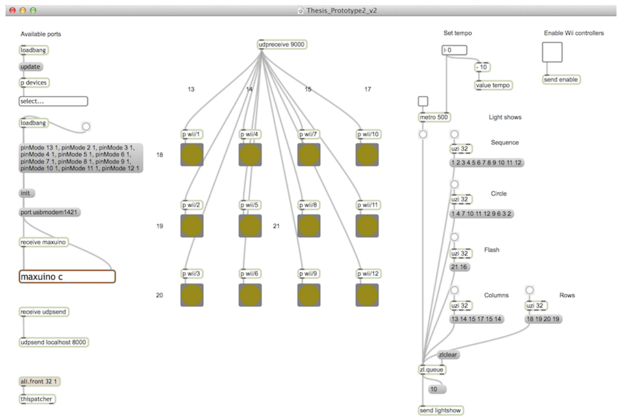


Figure 5.17: Control and monitoring in Max

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 5.16). 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. An additional method of visual feedback was added at this stage as well. While one LED would remain illuminated at all times, a registered clap input would cause all four LEDs on a user's controller to momentarily flash in sync with their connected light on stage.

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 it would 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 5.17 shows the Max interface that was designed

Figure 5.18: The Silver Dollar Room

to control and monitor the lights' activity. For the first part of the show I could trigger preprogrammed lighting patterns, and for the second part I could activate the controllers and oversee 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.

5.3.2 Testing

The prototype was tested at The Silver Dollar Room, a historic, two-hundred-capacity bar located in downtown Toronto (see Figure 5.18). 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 approximately forty 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.

Due to the number of artists performing, the changeover between sets had to be quick.

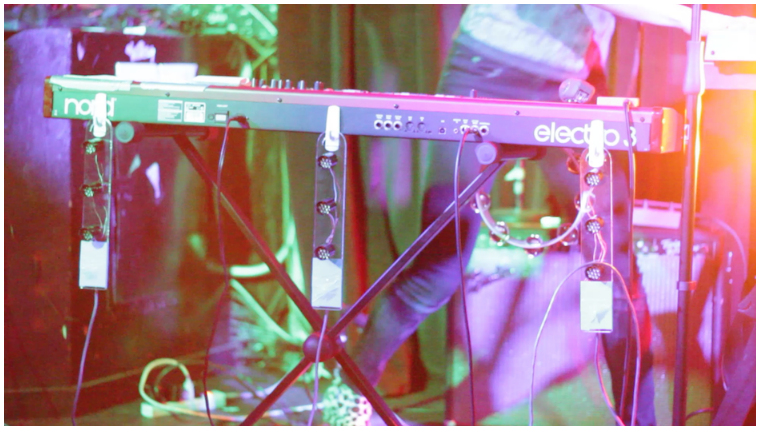


Figure 5.19: Hanging lamps

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 5.19. 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 5.20 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 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

Figure 5.20: The lights flash as Christian Hansen performs

Figure 5.21: Audience members move with the controllers

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 their 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 holding 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 random 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, a percussion 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 that were 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. There were no users who were noticeably influenced by alcohol. Figure 5.21 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 frequently 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 5.22 captures these moments.

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

Figure 5.22: Christian and Molly interact with the crowd-controlled lamps

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 had been dancing frantically through the whole performance 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 Christian Hansen 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. "It was a pretty easy setup. It worked on stage," he said. He indicated that he would like if the lamps had their own stands and could be set up on either side of the stage. He also expressed interest in having some of the lights attached to his microphone. The lights were most effective, he felt, when the venue's house lights were kept low. In general, Christian and Molly had begun thinking about how, logistically, they could tour with this technology and adapt it to different venues.

Once the audience received their controllers, Christian 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 by making the output more "visually significant" or using less lights. Christian believed that the audience had enjoyed 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.

Christian noted that the show had a "medium" turnout, and the crowd was a mix of people both familiar and unfamiliar with the band. He explained how different types of shows are handled differently. "I feel the difference," he said; 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."

There was a particularly memorable moment for Christian when both 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,” he warned. He indicated that the occasional randomness of the flashing lights was not a distraction, stating that he “was ready for that.” The only thing that would have been distracted him, he said, was if something malfunctioned.

Christian thought that introducing the devices for the last two songs was a good choice. He felt that giving people control for an entire performance would probably not work out, admitting, “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,” he said. The lights could be in the band’s control for some parts, in the audience’s control for others, or sometimes off altogether; he suggested that some signal could indicate when things change. Christian also proposed that the lights could be moved to different parts of the stage throughout the performance. The band could effectively “write the script” for where and how the lights illuminate.

5.3.3 Analysis

Prototype #3 was an overall success. Every component functioned as expected for the duration of the performance. Ultimately, the testing resulted in several surprising observations of the audience and an insightful discussion with the performer.

The input method was interpreted by users in many different ways. Contrary to expectations, the motions most users were performing were not based on typical audience actions, but at times closely resembled the playing of a percussion instrument. It seems as though the ambiguous form of the device gave people options on how they would like to hold and use it. Designing with ambiguity in this way could promote creativity and give users more freedom; however, one should be sure that unexpected usage does not have adverse effects. The lamps fortunately still responded regardless of the controllers’ orientations, but the direction-dependent LEDs, for instance, were rendered meaningless when a user flipped their device upside down or sideways, no longer serving to help them identify their light. This finding brings to mind Turino's (2008) concept of "wide tuning" in participatory performances; even if participants' behaviours differ, they should all be able to contribute equally.

The concept of audience-controlled lighting was compelling to users overall, but some questions remain unaddressed. For example, this system relies on the participation of each person holding a controller; if most of the users stopped moving, most of the lights would stop flashing, and the effect would diminish. A future iteration could remedy this by adapting to a changing number of participants. It could also reward highly involved users with more control, similar to Feldmeier and Paradiso's (2007) interactive dance club. Previous prototypes were inherently collaborative, implementing many-to-one output and goal-oriented prompts. This iteration, however, did not influence users to collaborate in any way. While the one-to-one mapping connected each audience member with the performance individually, it did not incite communication amongst the crowd. Is this an issue? Is it beneficial for audience members to participate collaboratively, or is it enough that they are contributing to the performance at all? These questions must be addressed in the future.

The instant and direct feedback provided by this prototype seemed to help users quickly understand their role. Christian, however, expressed interest in giving users a "bigger payoff." Could this be accomplished by using bigger or multicoloured lights? Freeman (2005) stressed that it is impossible to satisfy every member of an audience. Thus, perhaps there is a balance to strike between easy-to-grasp simplicity and a satisfying payoff.

The most appealing aspect of this prototype may have been that it gave the audience some influence over what happened on stage. Rather than creating a network connecting all users together, this system instead created a bridge between those off stage and those on stage. This bridge took the form of the four lamps, which turned into rather compelling artifacts. When the audience had control of the lights and the performers held the lamps in their hands, a new kind of interaction formed. Christian and Molly could direct the lamps and aim them towards the crowd or hold them under their faces, but it was the audience members that chose if and how the lamps were illuminated. The lamps were communal 'instruments' that could be 'played' by both parties simultaneously. This is tied closely to Bongers' (2000) distinction between reaction and interaction. The lights react to the audience, but "real interaction" occurred only when the performers began manipulating the lamps as well.

Looking to the future, Christian had expressed interest in making the system more dynamic and able to function for an entire performance. It will be a challenge to create an experience that remains exciting for this amount of time. Implementing different types of inputs or outputs could accomplish this, but is this feasible? Turino (2008) suggests that a main feature of the participatory performance is constancy; would continually changing the system's rules cause too much confusion?

Chapter 6

Conclusion

This chapter summarizes the results of the research that was carried out and their implications with regard to the research questions. Lastly, possible directions for future research are discussed.

6.1 Discussion

This thesis investigated how digital technology might be used to introduce new forms of audience participation at rock concerts. A user-centred design process was implemented, breaking the research question down into modular problems – investigating the input, feedback, output, and overall experience of a participatory technology. Ethnographic studies were conducted, followed by three phases of prototyping. These research methods proved to be effective tools. Obtaining a deeper understanding of both concertgoers' and performers' perspectives provided a solid foundation from which the prototypes could emerge. Each prototype then managed to address the research questions in different ways, building off of previous iterations' findings. Talking to users – both audience members and performers – provided valuable insight into how the prototypes had performed.

A number of major themes emerged upon analyzing this work, yielding numerous possible solutions to each of the research questions.

Experience

It is clear that participatory technologies are of interest to both performers and music fans. While it is to be expected that not all musicians will agree, those interviewed expressed curiosity towards experimenting with new methods of audience participation. Christian Hansen is an active member of the participatory culture and is especially open minded. After experiencing the third prototype firsthand, he was interested in developing the technology further. In particular, he believed that the system could become a useful storytelling device. Concertgoers surveyed in the ethnographic study did not voice a need for a new method of participation, but they were generally interested in how new technologies could be incorporated into shows. According to the questionnaire, music fans that frequently go to small-sized concerts are more inclined to engage in participatory culture. Indeed, those that attended the relatively small show during which Prototype #3 was tested were eager to grab a controller. These users all responded positively to being in control of the lights, and many became physically engaged in the performance. Thus, participatory technologies have the potential to enhance live music experiences for both performers and audiences.

Input

Multiple methods of input were analyzed to find how to best retrieve information from audience members. While their buttons caused some distraction, the Wii controllers were mostly flexible and problem-free input devices. As related work (Ulyate & Biancardi, 2001; Maynes-Aminzade et al., 2002) and the ethnographic study indicated, movement-based inputs were welcomed by users. Previous research more specifically recommended audience-controlled systems be based on already-present behaviour (Barkhuus & Jørgensen, 2008). Methods like clapping and doing the wave certainly were intuitive for users testing the second prototype. However, those participating in the third and final experiment exhibited more abstract motions. It became clear that allowing for creativity yielded the best results. Giving the input device an ambiguous form let participants hold it and move with it in the way that came naturally to them. Mirroring Turino's (2008) concept of "wide tuning," robust programming was also important to ensure that, if the device was used in an unexpected way, the system still responded correctly; users holding their Wii controller sideways, for example, were still able to illuminate their light. Other precedent research investigated promoting collaboration in groups (Freeman, 2005; Feldmeier & Paradiso, 2007), and Prototypes #1 and #2 confirmed that collaboration can occur naturally in interactive systems. Prototype #3 conversely isolated each user's inputs and instead connected them to their own object on stage. While this did not facilitate collaboration within the crowd, a satisfying connection between the audience members and performers instead emerged.

Feedback

Great importance was placed on immediate and obvious feedback in past work (Ulyate & Biancardi, 2001; Barkhuus & Jørgensen, 2008). The first two prototypes confirmed that this was necessary in order for users to easily understand the effects of their inputs. Users did not want their inputs combined with others', and they preferred looking at direct representations of their actions over obscured visualizations. Prototype #3 provided direct feedback to each user individually. The twelve users were able to easily identify the light under their control. This simple one-to-one mapping was the most direct way to avoid the uncertainty that could arise in a many-to-one system, such as in Prototype #1. The binary, on/off functionality also got rid of the goal-oriented nature created by the first prototype's left-versus-right voting mechanism. While the third prototype made use of LEDs on the controllers for additional visual feedback, this was rendered meaningless to users who held the devices in an unexpected orientation. Thus, it is important that feedback systems are not based on assumptions about user behaviour.

Output

Freeman (2005) successfully gave an audience control over an orchestra's musical output, but, after speaking with musicians, it became obvious to me that this model would not work for a rock concert. A typical performer does not want to give their audience too much control. Similar to the PixMob and Wham City Lights projects, Prototype #3 successfully made the audience a part of the performance by letting the control the light show. In addition to engaging audience members, the performer felt that this complemented the music without being a distraction. A particularly pleasing outcome came from where the audience's and performer's influence intersected. The final prototype's lamps became communal interfaces, being physically handled by the performers yet illuminated by audience members. In Bongers' (2000) words, this turned the system from "reactive" into "interactive." Perhaps a participatory technology is most effective when this threshold is crossed; 'true interactivity' may be a requirement for a truly participatory performance. Allowing an audience and performer to participate in the same performance, then, is not just accomplished by providing the crowd with a new output, but by augmenting the performer's output as well.

6.2 Future Directions

Future work will advance the last prototype and address questions unanswered by this thesis. Continuing the collaboration with Christian Hansen, the next iteration will be implemented for a longer portion of a performance. The technology's parameters will change as the show progresses, introducing new forms of interaction that reflect the flow of the performance. This could be facilitated by the performers utilizing the lamps in new ways, or the system could activate new rules or features, such as lights of different colours. Will this variety of participatory forms keep the audience engaged, or will the continual changes frustrate and confuse them? Another improvement that must be made is to allow for more audience members to be involved. An increasing number of users, however, will eventually make the current prototype's one-to-one mapping system ineffective; a new method of feedback will have to be formulated. Future iterations will also be able to adapt to individuals' behaviours. A listless user and one that is moving frantically, for instance, should not be producing the same type of output. If some users are not participating at all, the system should reassign their bandwidth rather than letting it go unused.

New technologies will also be investigated. Bluetooth low energy (BLE) is a recently introduced standard that will make input devices smaller and lighter with a long-lasting battery. The LightBlue Bean[1] makes use of BLE and would serve as a flexible prototyping platform. These devices can be networked together and allow data to flow between a scalable

[1] `http://launch.punchthrough.com`

group of users.

Looking further ahead, additional uses of participatory technologies will be investigated. The data being provided by audience members, for instance, could be collected and analyzed. Perhaps examining audience activity throughout a concert could help performers understand the responses to particular songs and inform how they organize their sets. With the world of rock music thoroughly explored, experiments will also be run within other genres of music. How would a participatory technology fare at a jazz club? If enough interest is shown in the system, a market study will be performed to evaluate its viability as a commercial product. Artists and promoters may be interested in purchasing participatory technologies, prepackaged or personalized to their needs, in order to add a special element to their live show.

6.3 Conclusion

This thesis showed that simple digital technologies can give audiences enjoyable new methods for participating in rock performances. While presentational performances will always divide audience and performer, promoting participation reinforces one of music's most important functions – bringing people together.

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Appendix A

Research Ethics Board Approval

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,

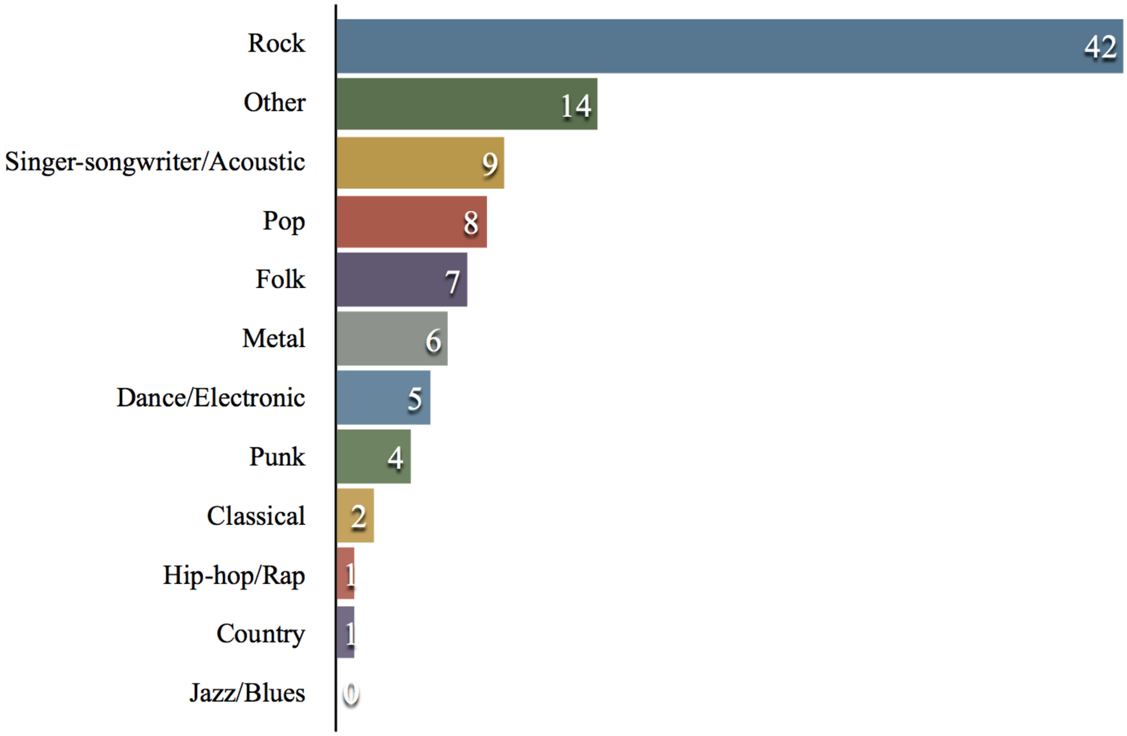
Tony Kerr, Chair, OCAD U Research Ethics Board

OCAD U Research Ethics Board: rm 7520c, 205 Richmond Street W, Toronto, ON M5V 1V3
416.977.6000 x474

Appendix B

Audience Questionnaire Results

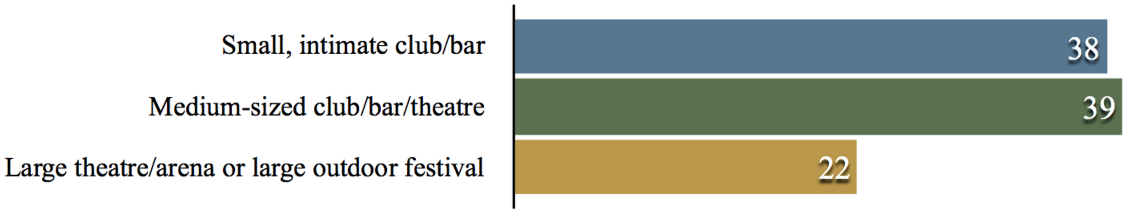
1. **What genre of music do you most often see performed live?**



"Other" responses:

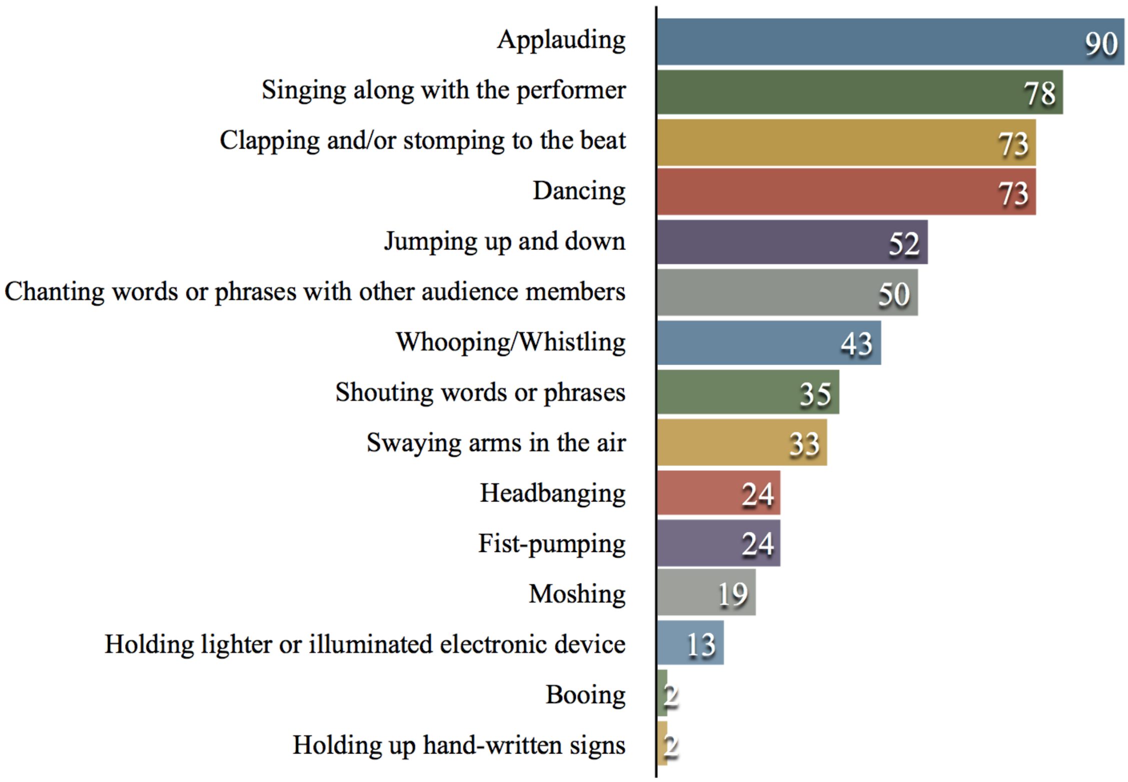
Progressive Rock	Indie Rock
Americana	Canadian Indie
Canadian indie	alternative/indie
Indie rock	Post-Everything
Alternative	Can Indie all genres
Indie Alternative	Indie
a pretty even split of songwriter/pop/rock/punk/folk	Jam bands

2. **At which kind of venue do you most often see live music performances?**

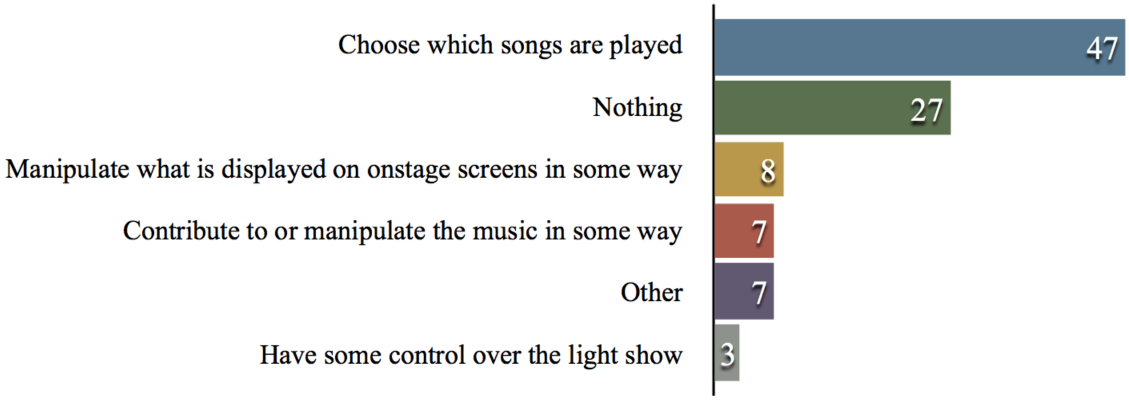


3. On average, how many live music performances do you attend?

4. In which of the following do you regularly partake at live music performances? (Select all that apply)



5. If you could directly participate in a live music performance in some way, what would you most want to do?



"Other" responses:

Play an instrument with the artist	Be on stage
Fix the mix.	Concentrate
Interact with performers by having them notice my enjoyment of their performance	It would be really cool to be on stage–maybe play the tambourines or some other low-skill job
buy them a drink, high fives	

6. If you could send a message to your favourite artist while watching them perform live, what would it be?

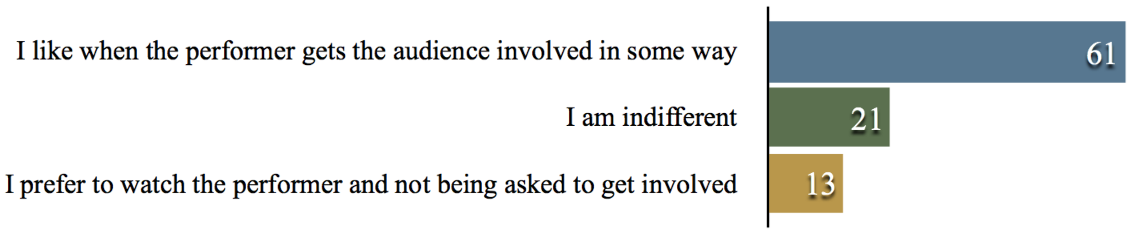
"I love you!" or "This is my favorite song!" or "Play _____!"
Appreciation of some sort.
Stop looking at this message and play your music
Loving the show thanks
I love this song sooooo much!!! – AND/OR – You make the world a better place!!
"You're amazing! Play *insert song here*!"
Keep on rocking
I love your music and I wish you'd come back and play for us more. To me, you're the greatest live band there is!
Thank you

I think you guys are a real inspiration
I'm not sure, but I'd want to send them something so outrageously bizarre and stupid that it catches them off guard.
play my favourite song!
I would let them know how awesome they were!
Can I get a picture/autograph after the show!!
pertinent to EDM specifically, but when I go out to see an artist, I'd rather hear his/her music rather than a radio show or misc mix. if I wanted to hear your weekly sirius show, I'd listen to it–if I'm paying time and money to see you live, I want to hear YOUR music, so I can vibe to it with the crowd and not just on my own.
THANK YOU.
Don't do anything outside your comfort zone. Just put on the most intense performance you can.
None
Awesome job! Play an encore!
WSO you magnificent people, you.
Nothing. I don't want to interfere with their craft; I want to react to it.
To ask them to play my favorite songs if they don't normally play them.
you're doing great!
Thank You for coming!
Thank you for sharing your art with me!
That I love what they're doing and their music changes lives
You gave me hope.
just that i freaking love you guys i love you okay and you have changed my life
I LOVE YOU, MATT MAYS!
I love you and thank you.
YOU DA BEST
I have no idea.
Will you marry me?

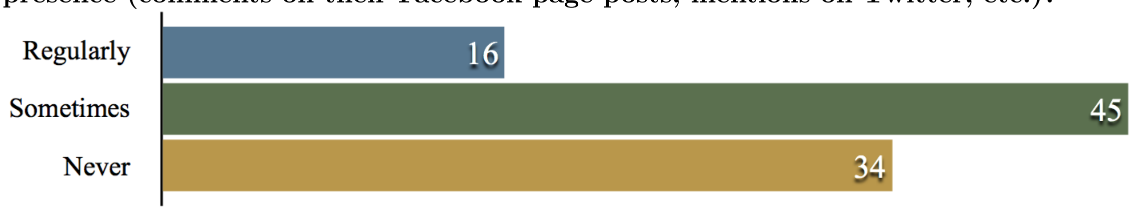
More rock, less talk!
Try harder. Amaze me, goddamnit.
Don't stop.
Not sure
Play______ or your guitar is out of tune dummy
your music has changed my life!
I would not want to send a message. It feels invasive to do this.
Don't bury the vocals.
Thanks!
N/A-they don't need me to send a message while performing. I can talk after the show
I Love You!
Do me.
You're blowing my mind right now. I wish we could just sit down and chat music for a while. But we're both shy. So it'd get weird.
That a particular song is my favourite/that they should play my favourite
I love you all
-Ask for a favourite song, or a question about why a song was written, what the lyrics are based on, etc.
I would try to put my appreciation into words probably.
You fucking rock!
You. Are. God.
Play the hits
I'd want to tell them they're doing awesome
Nice going, keep it up.
I'd tell her how amazing the show is and how much she's influenced me in my own writing
Say something specific about my city!
Play some of your early stuff
take it off boyonce

I love you, please play my favourite song ....
You're brilliant.
Thank you.
play the hits, or keep it up/you're awesome
That was fantastic!
Please don't always encourage audience to sing along to every song as it takes away from your beautiful voice.
"you rock" or "this song kicks ass" or things like that.

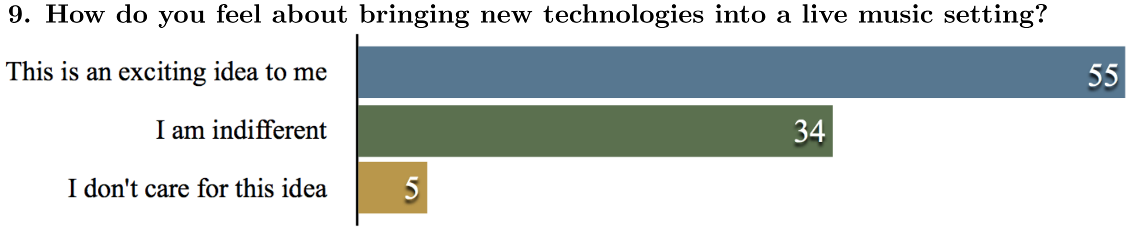
7. How do you feel about being involved in a live music performance (being asked to clap/sing along, call and response, etc.)?



8. How often do you interact with musicians through their social media presence (comments on their Facebook page posts, mentions on Twitter, etc.)?



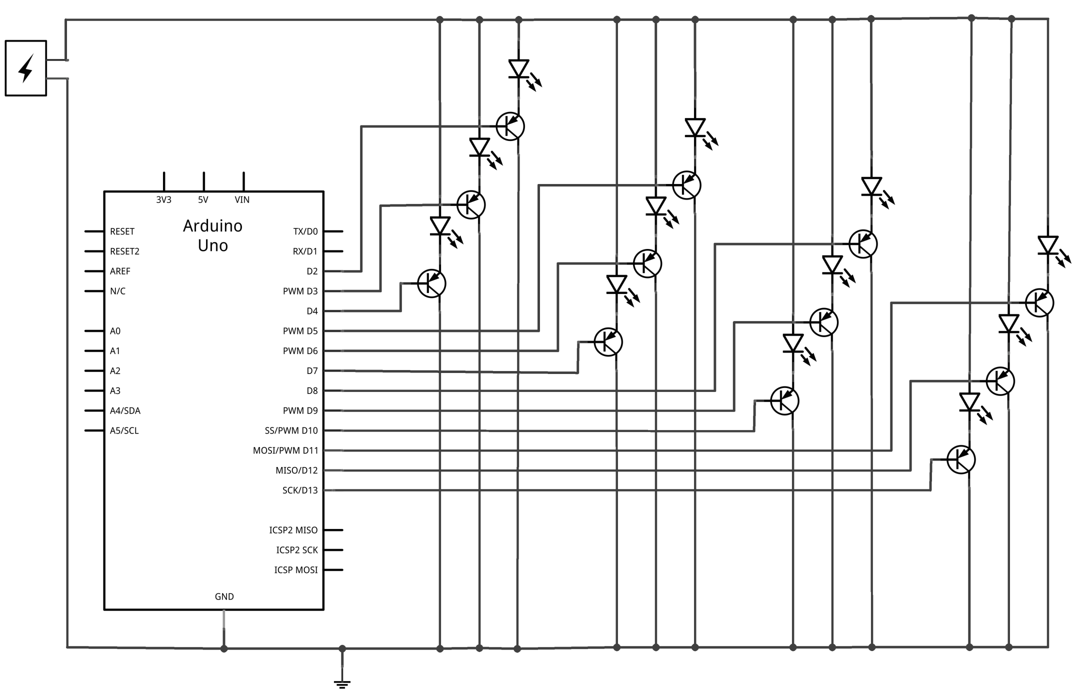
9. How do you feel about bringing new technologies into a live music setting?



Appendix C

Prototype #3 Circuit Diagram

The following is a simplified circuit diagram for Prototype #3. The power source provides 12 V and 1 A. All transistors are P2N2222A NPN devices. Each LED symbol represents a bulb containing a 12-LED array; each bulb draws approximately 80 mA at 12 V.



Appendix D

Accompanying Material

The accompanying video file contains footage of the testing of Prototype #3.

The following accompanying material is available upon request from the Ontario College of Art & Design Library:

1 DVD containing footage of the testing of Prototype #3

Anyone requesting the material may view it in the OCAD Library or pay to have it copied for personal use.