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

by

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Abstract

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

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Chapter 1

Introduction

At the 2011 Coachella Valley Music and Arts Festival, Monteal-based indie rock group Arcade Fire are about to play one of the final songs of their headlining set. The guitar riff from the band's hit song "Wake Up" is instantly recognized by the audience, who cheer loudly with excitement. The song reaches the first chorus, and, suddenly, one thousand white beach balls begin tumbling over the top of the stage and gently falling onto the crowd below. The cheers swell into a roar as the balls disperse over the mass of people. When the band hits the song's final chorus, to the spectators' 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 grab on to the beach balls; cars 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 extended a live music performance into the audience. Large rock concerts seem to be growing more technically complex and spectacular all the time. Powerful equipment makes shows

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

louder, larger, and flashier. Only recently, however, have many mainstream artists begun investigating how technology can benefit not just the performance on stage, but the interactions within the audience as well. This thesis examines these sorts of technologies, asking how they might be used to make conventional rock concerts more participatory.

1.1 Motivation

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

Many technologies exist for creating enhanced presentational performances. In general, they are implemented to aid the artist in presenting their music to the audience. When The Beatles did their first tour in North America, for example, they had 100-watt amplifiers custom made to ensure their music could be heard over the incredibly loud cheers of the fans; ultimately, the equipment was not nearly loud enough to overpower the audience (citation). Today, a large arena rock show might implement sound systems demanding tens or hundreds of thousands of watts (citation), enough power to send strong vibrations through concertgoers' bodies or even, after enough exposure, cause hearing damage. Performers may take advantage of enormous screens that provide far-away fans with close-up views of the show. Complex lighting rigs, laser arrays, and flashy visualizations are also common methods of turning a regular performance into an awe-inspiring spectacle. Recently, improved webcasting technologies have allowed for the live streaming of concerts over the Internet; a U2 concert streaming on YouTube in 2009 generated ten million pageviews, vastly increasing the reach of their performance[2].

There is clearly a great deal invested in enhancing the presentational aspect of live music performances in Western culture. As Turino points out, when it comes to presentational performances, profit making is usually the primary goal. Louder speakers and bigger screens mean artists can play larger venues with more seats to sell to fans. On the other hand, Turino admits that participatory performance does not fit well within capitalist societies: "Participatory traditions tend to be relegated to special cultural cohorts that stand in opposition to the broader cultural formation" (p. 36). Why, then, might we want consider technologies that enhance the participatory aspect of performances? As stated by Turino, disregarding its potential financial value, it is music's function as a social interaction that holds the most value for humans. Levitin (2008) agrees, stating that the social nature of music may have been an important evolutionary adaptation that helped early humans thrive in groups: "Singing around the ancient campfire might have been a way to stay awake, to ward off predators" (p. 258). Thus, while we may no longer depend on participatory performance to the degree that our ancestors did, it seems as though it is against human nature to continue widening the gap between audience and performer. Artists are placed on brightly lit stages with booming sound systems, allowing their voices to echo through stadiums; the voices of audience members, meanwhile, become meaningless noise as more and more people are packed into venues. How might technologies instead be used to embrace the social functions of music and let everyone – performer and audience – be a participant? This attitude is, fortunately, reflected in some of the ways we are using technology today.

The Internet has connected performer and audience in a new way. Social media allows for unique interactions between artists (big and small) and their fans. A small touring band, for example, might send out a message to their followers on Twitter asking for restaurant

[2] http://www.wired.com/business/2009/11/4-ways-live-and-digital-music-are-teaming-up-to-rock-your-world

suggestions in a town they are passing through. More well-known artists may have difficulty connecting to their growing fan base, but events like "Ask Me Anything" question-and-answer sessions on Reddit allow them to directly answer questions from their supporters. Beyond these social media interactions, the Internet is also continually supplying new ways for musicians and fans to connect. Crowdfunding platforms like Kickstarter rewards fans for directly funding artists' projects by giving them exclusive gifts; Feedbands[3] lets users vote for their favourite musicians each month, and the winning artist gets their record pressed on vinyl in a limited-edition run; using Alive[4], Japanese promoters can ensure shows get adequate turnouts by having concertgoers commit to buying tickets before artists are even booked to play. The Internet has afforded many new types of participatory experiences for musicians and fans. Recently, digital technologies are being used increasingly to enhance this connection during live performances themselves.

As the music industry continues attempting to find its footing in the digital age, ticket prices for concerts are steadily increasing – seeing a 40% increase from 2000 to 2008, for example[5]. It seems then that, in order to ensure patrons are getting their money's worth, it is important for performers to deliver a truly unforgettable show. Stages, lighting, and visuals are certainly becoming more extravagant. Some artists, however, are looking to more innovative solutions to wow their audiences. Arcade Fire and Coachella, as described above, succeeded in creating a memorable live music experience using hundreds of wirelessly controlled LEDs. Wham City Lights created a similar experience by using a smartphone application to turn audience members' personal devices into a synchronized light show[6]. Other instances allow for more direct interactions. At a special performance by R&B artist Usher, for example, fans could send tweets about the performance that would appear on the large screen onstage and then morph into abstract animations[7]. Plastikman, alter ego

[3] `http://www.feedbands.com`

[4] `http://www.alive.mu`

[5] `http://www.musicthinktank.com/blog/the-beatles-tell-us-that-weve-hit-the-concert-price-ceiling.html`

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

[7] `http://www.momentfactory.com/en/project/stage/Amex_Unstaged:_Usher`

of Canadian DJ Richie Hawtin, released a smartphone app to accompany his 2010/2011 world tour; fans with the app could view a live video stream of the performer's perspective, reorganize audio samples that Hawtin would use in his performances, and participate in a live chat with other users during the show[8].

There are countless types of performance exhibited by the world's various cultures – some more presentational, some more participatory. In Western cultures, presentational performances draw the biggest crowds, and technologies are being developed to make them larger, louder, and more lucrative. We must remember, however, that music is an inherently social activity; by continuing to separate performer and audience, we are potentially reducing its impact as an event that brings people together. Thus, it is valuable to consider how we might use technology to enhance not the presentational aspect of a concert, but the participatory. The popularity of the aforementioned internet services proves the public's desire for deeper interactions with artists, and recent experiments with interactive systems at live performances have produced impressive results. Lastly, participatory technologies at rock music performances have yet to undergo an academic investigation. I believe, then, that it is worthwhile to survey this fledgling field and better understand its implications on the modern music performance.

1.2 Research Question

* How might rock performances be made more participatory through the amplification of audience actions?

* Sub-questions:

- How do audience members want to participate? How do performers want their audience members to participate? How might a system be designed that enhances the concert experience for both parties?

- How can an audience best provide inputs for a system? How can the system best provide

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

feedback to the audience?

* Provide my definitions for ‘participatory,’ ‘enhance,’ ‘feedback,’ etc...

* Justification:

- Music is participatory by nature, so it is worth examining how we might stop this characteristic from being suppressed in modern-day performance.

- The case studies in the previous section prove there is interest in creating new participatory experiences at live shows. Observing them from an academic perspective will offer insight for similar projects in the future. Furthermore, the live music industry continues to grow; it is worth investing how they might evolve.

- Most of the research done on crowd interaction does not feature an active performer as the center of attention. Designing an interactive system for a rock show is bound to present different challenges than a dance club, for instance.

1.2.1 Research Methods

* I will be performing qualitative research to address my research questions.

* Ethnography: Examining cultural phenomena within a group. Surveying modern music fans will provide me with a general sense of their feelings towards music, live performance, and technology. I will interview active musicians to understand how and why they interact with fans, on and off stage, and what they think of new technologies in a performance setting. These methods will allow me to gain a deeper understand the users and environments that are related to my work.

* User-centred design: The users’ wants and needs drive the design. Prototypes will be tested with users. Observations and interviews with the participants will help answer research questions as well as validate or disprove any assumptions that have been made. Both audience and performer perspectives will be represented. This method will help establish design guidelines.

1.2.2 Scope

This work brings up some other topics that, while interesting, will not be addressed here. For example, while there exist a wealth of music genres and performance styles, I will be focusing on Western rock concerts performed in standard venues. These environments are commonplace and can accommodate large audiences who are generally free to move around and be vocal; additionally, they are places that I feel comfortable and familiar with. Many of the projects I reference were dependant on a large budget, but, to avoid placing limitations on my own work, financial matters will not be considered. These sorts of issues are outside the scope of this project.

1.3 Overview

- **Chapter 2: Literature Review**

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

- **Chapter 3: Ethnography**

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

- **Chapter 4: Protoyping**

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

- **Chapter 5: Conclusion**

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

Chapter 2

Literature Review

2.1 Background

This chapter investigates music's history as a human activity, and the concepts of participatory and presentational performances will be explained. I discuss how presentational performance has evolved into its current form and how rock music and technology are bringing participatory elements back into concerts.

2.1.1 Music and Performance

Music is a part of being human. "The archaeological record," Daniel Levitin (2006) explains, "shows an uninterrupted record of music making everywhere we find humans, and in every era" (p. 256). Early music making was purely rhythmic, with simple objects being used as percussion instruments. As primitive wind and string instruments were crafted, rhythm was joined by melody. Music making gradually evolved in cultures all over the world, and it has grown to serve many different purposes. In New Guinea it is a gift to one's host; in the Democratic Republic of the Congo it is used to settle lawsuits; Australian aboriginals use music to tell intricate stories; and some African tribes believe repeating musical chants can draw harmful spirits out of inflicted individuals (Jourdain, 1997; Turner, 2011). In modern Western cultures, of course, music is everywhere – performed at live concerts, scoring film and television, being shared on the Internet. Regardless of culture, there is no denying that music is an inherently social activity.

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

In his book *Music as Social Life: The Politics of Participation* (2008), Thomas Turino divides music performance into two categories – participatory and presentational. Most cultures exhibit some sort of participatory performance. Peruvian communities perform in large groups with each participant either dancing or playing a panpipe or flute; many different religious ceremonies involve singing in unison or in a call-and-response structure; line dancing in North America features choreography that is closely tied to the music. In general, the emphasis is on the intensity of the interactions over the quality of the performance, and participatory performances have characteristics that support this. In a purely participatory performance, Turino explains, "there are no artist-audience distinctions, only participants and potential participants performing different roles, and the primary goal is to involve the maximum number of people in some performance role" (p. 26). Equality among participants can lower self-consciousness and lead to a more relaxed atmosphere. Having different roles, on the other hand, allows individuals of different skill levels to contribute accordingly. "Core" and "elaboration" roles, in Turino's words, cater to less- and more-advanced performers, respectively; core participants keep the performance moving along while elaboration participants add flourish. Another common feature of participatory performances is repetitiveness. This open form allows newcomer participants to easily join in. Additionally, Turino explains, there is a "security in constancy" that allows performers to become more comfortably immersed in the music. Performances may also incorporate loud volumes, densely overlapped sounds, and loosely tuned instruments as "cloaking function" 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.

The opposite of the participatory performance is the presentational performance. Here, the performer presents prepared music pieces to an audience that does not directly participate in the performance (Turino, 2008). A typical Western rock concert is a good example: a band on a stage performs rehearsed songs to an attentive audience whose main role is listening to the music. In contrast with the open form of participatory performances, here there is a focus on detail, smoothness, and coherence. These performances are generally closed form; the artist knows how the show will begin and end. While participatory performances rely on constancy, planned contrasts are implemented in presentational performances in order to keep the audience's attention. A rock band will often break up a song with a guitar solo, for instance. Participatory performances foster connections between participants, Turino explains, whereas presentational performances seem to tease a connection between artist and audience without ever realizing it: "leave them wanting more." Indeed, the goal of a presentational performance is typically to sell as many tickets as possible. It is, in fact, this desire for profit that caused the evolution of presentational performances over the last few centuries.

2.1.2 Evolution of the Presentational Performance

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 middle class would see live performances as opportunities to display their newfound wealth. These "traveling virtuoso-entrepreneurs" made money touring from town to town and performing in local parlours for a fee. By the 1800s, ticketed events were gradually becoming more abundant and "art music" concerts began transforming the state of the live performance. These were seen as formal events, says Jourdain, and those wealthy enough to attend were expected to follow the established etiquette – sitting quietly and listening. Music listeners had been turned into consumers.

Music consumption in the last century has transformed due to a relatively recent development – recorded music. Wax cylinders, records, cassette tapes, compact discs, and digital files have allowed listeners to experience music performances from the comfort of their homes, and, today, a concert's purpose is typically to 're-present' these recordings. This does not, however, mean that performance has become subordinate to recorded music. Small (1998) maintains that "performance does not exist in order to present music works, but rather, musical works exist in order to give performers something to perform" (p. 8). Recordings are just blueprints for performance. He also suggests that, since technology now allows people to experience performances at home, the significance of a real live performance actually increases. There are certainly aspects of a live music performance that cannot come from recorded sound. Musicologist Jane Davidson (2006) explains, for instance, that many musicians seem to perform better when in front of an audience; thus, it is possible that the quality of a live performance often trumps that of a recorded performance. Live performances can also be great sources of cultural influence. Ian Inglis (2006), a sociologist studying music performance, agrees: "In its ability to simultaneously reflect and influence patterns of socio-cultural activity, it is one of the principal avenues along which musical change and innovation can be introduced and recognized" (p. xv). For example, an event as momentary as the 1965 Newport Folk Festival – where Bob Dylan first went electric – seemed to change the course of both folk and pop music (Marshall, 2006). The loud guitar startled audience members, and Dylan was booed as he left the stage. Little did that audience know just how plugged in music performances would eventually become.

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

So why have visuals become such an important part of rock concerts? As Philip Auslander (1999) explains, live performance and mass media are in competition, and, since mass media is dominating, live performance has responded by imitating its competitor. Live sporting events make use of big screens and instant replays, for instance, and television shows and movies are regularly adapted for the stage. Live music performances, similarly, have been greatly influenced by MTV. As Music Television reached the height of its popularity in the 80s and 90s, concerts began looking more and more like music videos. For example, Madonna's live performance of "Like A Virgin" at the 1984 MTV Video Music Awards played out like a music video, the singer performing directly to the multiple television cameras and virtually ignoring the large audience beyond the stage (Burns, 2006). Jaap Kooijman (2006) points to Michael Jackson's performance of "Billie Jean" at the 1983 *Motown 25* concert, where Jackson's outfit and dancing directly referenced the song's music video. The crowd cheered as Jackson exhibited his signature dancing style – never noticing, or perhaps never caring, that he was lip-synching the vocals throughout. It is clear that technology has been driving the evolution of presentational performance. Modern concerts have truly become spectacles; but should modern concertgoers only be treated like spectators?

2.1.3 Return of the Participatory Performance

The presentational aspects of a rock show are more spectacular than ever. What, then, has happened to the participatory nature in which music traditionally thrives? What is the role of the modern concertgoer? David Horn (2000) provides the following definition:

> The popular music event is the sum of a number of smaller occurrences, which might include any or all of the following: the origination or the borrowing

> of a musical idea; the development of the idea; the conversion or arrangement of the idea into a performable piece; the participation of those (musicians, producers, technicians) whose task is to produce musical sound; the execution or performance of this task; the transmission of the resulting sounds; the hearing of those sounds (p. 28).

Out of all of the tasks associated with a live show, the audience is given one – "hearing." This spectatorial role developed as performers began "dominating" over the audience, Jourdain (1997) explains. 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 may be 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).

In the face of this established inequality, rock shows are usually environments that encourage audience involvement – presentational performances with participatory leanings. Crowds can join the music making by clapping or singing along, for example. They can add to the light show by holding up lighters or illuminated cellphones. Perhaps the simplest way for an audience member to become a participant is to move to the music; swaying, dancing, or joining the mosh pit are all methods concertgoers use to connect to performances. These activities may enhance the live experience for concertgoers, but they rarely have a significant impact on the performance as a whole. Some artists, though, go out of their way to allow the audience to affect the course of the performance. Elvis Costello has toured with a "Wheel of Songs," for instance, inviting audience members to spin the wheel and determine what tune the band will play next. The Flaming Lips dress willing audience members in ridiculous costumes and let them dance on stage for entire concerts. Green Day, playing to thousands of fans, will pull a select few on stage and allow them to play the band's instruments for one song before sending them backstage to enjoy the after party. These are certainly exciting examples, but they are far from involving each and every member of the crowd. We might ask, then – how can the participatory spirit of the rock performance be amplified?

As with most things that need amplifying (see the previous section), it seems that technology can provide a solution. Although Jourdain (1997) may consider technology a contributing factor to the decrease in participatory performances, there are recent examples proving that it can do the opposite. Before exploring how technology can help connect artists and fans at live performances, however, it is useful to observe how it is helping connect them elsewhere – via social media.

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" framed musicians as superior 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, adding intriguing new dynamics to relationships that had gone unchanged for so long. Artists can directly respond to fan message on Facebook or Twitter, for example, or organize question-and-answer sessions with the Reddit community. Soundcloud allows listeners to post comments as they listen to a song, praising or critiquing certain parts of the track. Many artists invite fans to create remixes of their work, and new services like BLEND.IO facilitate this kind of collaboration. These types of interactions are mutually beneficial; the audience gets to go deeper into the artist's world, and the artist gets to learn more about their listeners.

This connectedness is being increasingly utilized to alter live performances. 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. For each of their tour dates, alternative rock band Wilco provides an online form where fans can send song requests along with a note or dedication. Experimental performer Rich Aucoin gathers names of concertgoers, promoters, and other artists that are on the bill and projects text on stage individually praising each of them before his show begins. Many music festivals make use of social media channels during performances, displaying messages or photos posted by audience members on Twitter or Instagram. Artists will often share comments or photos from shows as well; Toronto band Born Ruffians, for instance, usually take a photo of their audience from on stage and post it on Facebook, allowing attendees to find and tag their faces in the crowd. The practice of 'bootlegging' – recording concerts 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, some artists, like Bruce Springsteen and the Red Hot Chili Peppers, are saving would-be bootleggers the trouble and providing free professional live recordings online after each show. Video recording is, to some degree, a contemporary version of this issue; fans film some or all of a performance on their personal devices and post the videos online. As with traditional bootleggers, there are musicians who are for and against this practice. It seems to be happening more and more often, for instance, that performers explicitly ask fans to keep their devices in their pockets. Radiohead and The Beastie Boys both embraced the concept, on the other hand, using fan-shot footage to create well-produced concert videos. While a performer's opinions may vary on all of the above-mentioned uses of technology, it is clear that they all allow for new levels of connectedness at a live performance.

2.2 Related Work

Work in human-computer interaction is referenced in this chapter, exploring group-controlled systems, creative collaboration, and audience-performer interaction. Real-world audience-based lighting systems are also reviewed.

2.2.1 Designing for Audiences

Designing for large groups of people has only recently attracted notable interest in the field of human-computer interaction (HCI). As interactive systems become increasingly ubiquitous, HCI researchers are asking how the needs of multiple people in a public space differ from those of an independent user. The characteristics of live performance make it an especially useful venue for these investigations; thus, conveniently, much of the research done in this field focuses on concerts, theatre performances, and dance clubs.

Maynes-Aminzade, Pausch, and Seitz

In their 2002 paper, Maynes-Aminzade et al. describe three different computer vision systems that allow an audience to control an on-screen game; they also outline the lessons they learned about designing such systems. The first method tracks the audience as they lean to the left and right. The control mechanism was intuitive, but the system required frequent calibration. The second method tracked the shadow of a beach ball which acted as a cursor on the screen. This was also intuitive, but it only involved a few people in the audience at a time. The third method tracked multiple laser pointer dots on the screen, giving each audience member a cursor; this was a more chaotic system once the number of dots got overwhelming. Lastly, the authors presented some guidelines for designing systems for interactive audience participation. They recommend focusing on creating a compelling activity rather than an impressive technology; they state that every audience member does not necessarily need to be sensed as long as they feel like they are contributing; and they suggest that the control mechanism should be obvious or audience members will quickly lose interest. The authors also note that making the activity emotionally engaging and emphasizing cooperation between players will increase the audience's enjoyment.

Aigner et al.

Aigner et al. (2004) here investigate how simple devices might be used to allow spectators to participate in the judging of sporting events...

Reeves, Sherwood, and Brown

This 2010 paper investigates the design of technology for crowds by observing and analyzing the behaviour of a group of football fans gathered at a pub. The authors note that most related work has focused on spectators at a performance or on exceptional circumstances like riots. This work instead looks at everyday crowd-based settings where there is no attention-grabbing "spectacle." To accomplish this, the researchers video recorded a crowd gathered at a pub during a football match and examined the group's behaviour for recurring themes. People were seen singing, jumping, and pumping their fists in the air in sync with each other. In general, these instances of collective participation were all visible or hearable from far away. Once a small group of people began the actions, they would quickly "snowball" and overtake the crowd. Researchers also noticed the importance of "shared objects;" an inflatable object bouncing between people, for example, connected individuals at a distance. It was also observed, of course, that not every person in the crowd cared to participate in these group activities.

After outlining these observations, the authors present a list of design lessons that they extrapolated. First, they suggest treating a crowd as a unit rather than a collection of individuals – for example, exploiting already-present crowd behaviours or allowing for only partial participation. The importance of "intra-crowd interaction" is also emphasized: allow for shared objects and space-dependent interactions, and take advantage of snowballing by encouraging highly visible/audible actions. Additionally, one should allow for interaction with people on the fringes of the crowd but be aware of problems that could be caused by latency. Lastly, the researchers note that every crowd is different and that each design should reflect the nature of the environment.

2.2.2 Creative Collaboration

Ulyate and Bianciardi

Ulyate and Biancardi (2001) here describe their "Interactive Dance Club" – a venue that delivers audio and video feedback to inputs from multiple participants – and they present the "10 Commandments of Interactivity" that guided its creation. The goals of the project were to create coherent musical and visual feedback for individual and group interactions and to allow non-artistic people to feel artistic. Inputs included light sensors, infrared cameras, pressure-sensitive tiles, proximity sensors, and simple mechanical switches. By interacting with them, users could make notes sound out, manipulate projected video and computer graphics, modulate music loops, and control the position of cameras in the space.

This project's "10 Commandments of Interactivity" contain the following points:

- Movement is encouraged and rewarded.
- Feedback from interactions is immediate, obvious, and meaningful in the context of the space.
- No instructions, expertise, or thinking is required.
- A more responsive system is better than a more aesthetically pleasing system.
- Modularity is key.

Lastly, the authors share the lessons that they learned while running the Interactive Dance Club. They observed that interactions involving full-body movements were most satisfying. The form of an object, they found, determined how users first attempted to interact with it. They emphasize the practicality of a system that is both distributed and scalable. Designing the interactions required finding a balance between freedom and constraint. They found that, no matter how elegant the system, some users would still find a way to create unpleasant noise. Lastly, they observed that instant gratification is important; feedback that is too delayed or interactions that require too much concentration are ineffective.

Feldmeier and Paradiso

In this 2007 study, the authors present a scalable system for wirelessly tracking the movement of a large number of users, allowing a crowd of dancers to influence techno music and lighting in a club...

2.2.3 Audience-Performer Interaction

D'CuCKOO's MidiBall

D'CuCKOO, a band active in the 1990s, frequently incorporated technology into their live shows. Their MidiBall was a large, wireless beach ball that triggered sounds and visuals on stage when struck by audience members...

Plastikman's SYNK

A smartphone application to accompany Plastikman's 2010/2011 world tour, SYNK allowed audience members to view the performance from the musician's perspective and even influence samples he played...

Bongers

In his 1999 paper, Bongers provides a theoretical HCI framework for physical interaction between performers, audience members, and electronic systems in a musical performance. He defines three types of interaction – "performer-system", "system-audience", and "performer-system-audience." Bongers models the interactions as control systems wherein actions are either a *control* or *feedback* process. Electronic sensors and actuators are discussed, followed by human senses and motor systems. Bongers states that a more convincing interaction is one that provides "multimodal" feedback – influencing more than one of the users' senses. Lastly, a few prototypes of novel interaction systems are described. Especially notable is the "Interaction Chair", which most easily fits in the performer-system-audience category. Here, the performer has the ability to send vibrations through each audience member's seat back, while the chairs contain sensors that allow audience members to influence visuals projected behind the performer. Other projects like this one can benefit from Bongers' theoretical framework; thinking in terms of control and feedback processes may provide new perspectives on a system's design.

Gates, Subramanian, and Gutwin

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

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

Barkhuus and Jorgensen

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

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

Tseng et al.

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

The authors approached this project by asking, “How can the audience become an essential element in a performance?” (p. 561). They claim that, while new media has been incorporated into theatre for decades, mobile phones have not been used to their full potential. Feedback collected after the performance revealed overall positive reactions. Some users, however, were uncomfortable having their personal devices connected to an unfamiliar network. Another negative was that not every audience member owned an iPhone; one of these spectators, though, maintained that she enjoyed the show even while being excluded from the interaction.

2.2.4 Interactive Light Shows

Wham City Lights

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

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

Xylobands

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

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

PixMob

PixMob is a patented wireless technology that enables the control of multiple LED-embedded objects. By giving PixMob objects to spectators, concert producers can create a controllable LED light show within the audience. The objects are activated with signals from infrared transmitters. Like normal lighting fixtures, the transmitters' beams can be shaped with lenses and controlled via the DMX512 protocol. The objects light up when they are hit by a beam, so patterns of moving light can, in essence, be painted across the audience. Light shows are programmed, simulated, and controlled through a software package called LAVA; they can also be controlled in real time using a MIDI controller or the LAVA iPad app. Previous PixMob objects include balls, wristbands, pendants, and beads, and custom object creation is available as well. PixMob also offers "second life" customization: objects can be programmed to react to sounds, play an mp3 track, or communicate with the user's personal computer after the show is over. Past clients include Microsoft, Arcade Fire, Eurovision, and Heineken.

Kasabian's 2011 Tour

UK-based studio Nanika helped Kasabian bring audience members into their live shows by turning cameras on the crowd and displaying their faces on onstage screens...

Chapter 3

Ethnography

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

3.1 Audiences

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

X.)

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

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

3.2 Performers

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

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

3.2.1 The Subjects

Erik

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

Blake

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

Christian

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

3.2.2 Interacting With Audiences

Erik

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

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

Blake

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

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

Christian

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

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

3.2.3 Participatory Technologies

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

Erik

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

Blake

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

Christian

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

3.3 Analysis

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

Chapter 4

Prototyping

4.1 Prototype #1

4.1.1 Motivation

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

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

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

4.1.2 Development

The first step in realizing this initial prototype was deciding on the hardware and software that would be used. Wii video game controllers have an abundance of sensors: they contain eleven digital buttons, an infrared sensor, an accelerometer, and a gyroscope (in the newer Wii Remote Plus models), and all of this data can be sent wirelessly to a receiver via Bluetooth. In addition to these affordances, due to the console's popularity, the Wii controller is also something that many people have already used before. With these considerations, I decided that the Wii controller was a suitable input device for my experiment. For my purposes, the easiest way to process the controllers' data was using a combination of two software packages – OSCulator[1] and Max[2]. OSCulator allows for communication between devices and audio or video software using the Open Sound Control (OSC) protocol[3]. Fortunately, this software is also specifically designed to communicate with the Wii controller. It can display live data from each sensor as well as activate the controller's LEDs and rumble motor. The data can then be sent to Max, a visual programming environment that is es-

[1] `http://www.osculator.net`

[2] `http://cycling74.com`

[3] `http://opensoundcontrol.org`

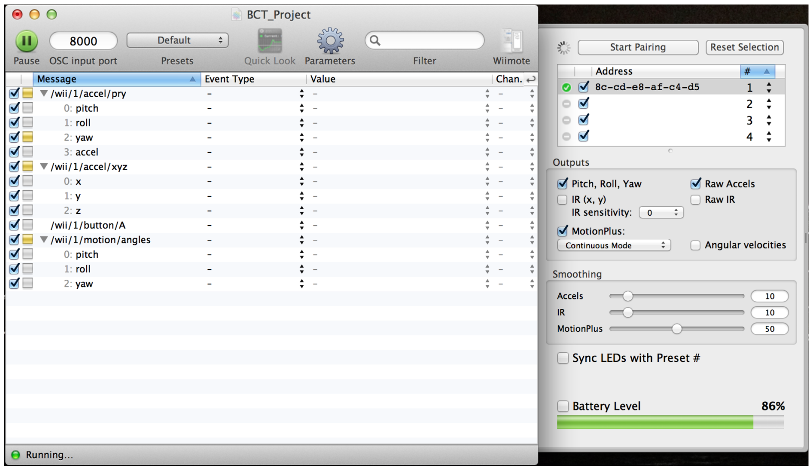
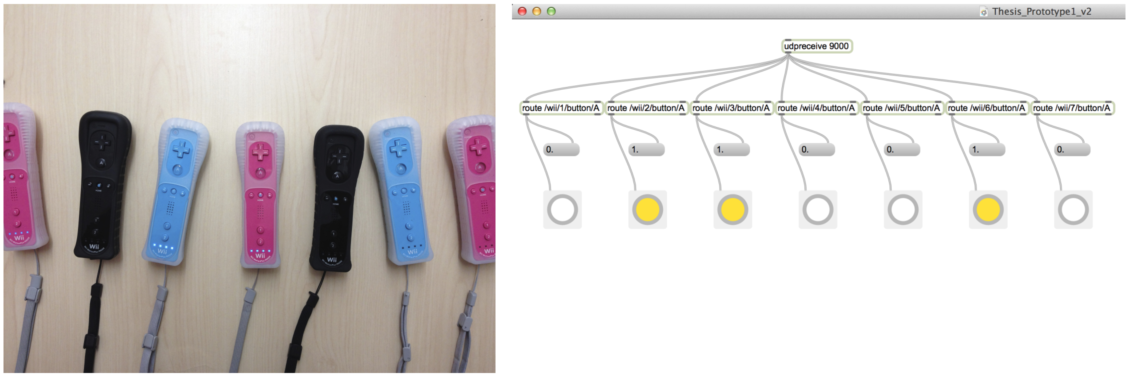


Figure 4.1: OSCulator software receiving data from one Wii controller

pecially useful for handling multimedia. Countless objects can be incorporated into a Max program (called a 'patcher') to manipulate numbers, audio signals, and video clips. Max is commonly used by musicians and video artists to create highly customized and interactive programs.

Syncing the Wii controller with OSCulator was simple, and I was immediately able to view movement and push-button data from my controller (see Figure 4.1). Next, I tested the limit of how many Wii controllers would be able to connect to my computer using the current setup. Since my thesis aims to give every member of an audience a new way to participate, this number would ideally be limitless. With Bluetooth technology, unfortunately, one master device (my computer) can only connect to a maximum of seven slave devices (Wii controllers). However, for the purposes of this prototype, I felt that seven controllers would be acceptable. A Max patcher was created to display push-button data from multiple Wii controllers. All seven were synced with no issues, and the program worked as expected (see Figure 4.2).

My next task was to create the VJ system. After experimenting with a multitude of video effects objects in Max, I created a basic program. The system is built around two short video loops that can be mixed together and modified. Users can crossfade between the two videos using the controller's Left and Right buttons. The resulting image can be



(a) Wii controllers

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

Figure 4.2: Testing simultaneous input from seven Wii controllers

rotated by rotating the controller sideways. Pixelation can be increased or decreased by increasing or decreasing the controller's incline. Finally, holding and releasing the A button enables and disables a motion blur effect. An important part of programming this patcher was mapping controller input to the effects controls. Values had to be carefully scaled and clipped in order for users' movements to translate naturally to the effect they control. I also carefully selected the source video such that the effects of users' actions would be clear; a black and white clip of one person dancing and a colour clip of multiple people dancing seemed to offer sufficient contrast (see Figure 4.3). The resultant patcher is pictured in Figure 4.4.

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

(a) Black and white (b) Colour

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

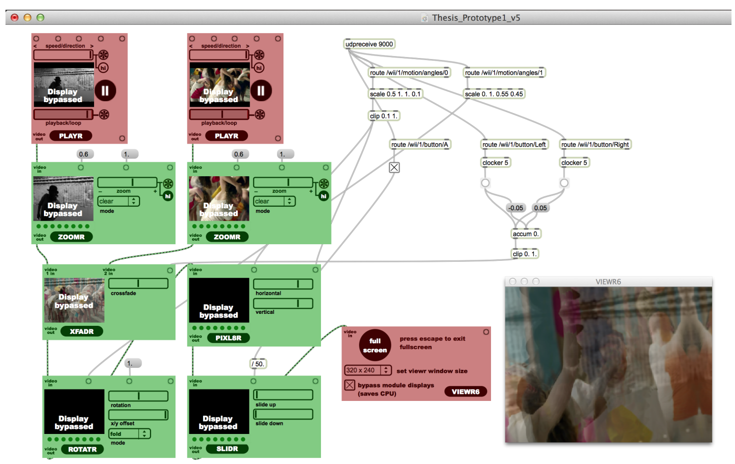


Figure 4.4: Wii controller VJ system

(rotation, pixelation, motion blur), the collective audience can progressively alter the tone of the visuals. This reflects Turino's (2008) core and elaboration roles, respectively.

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

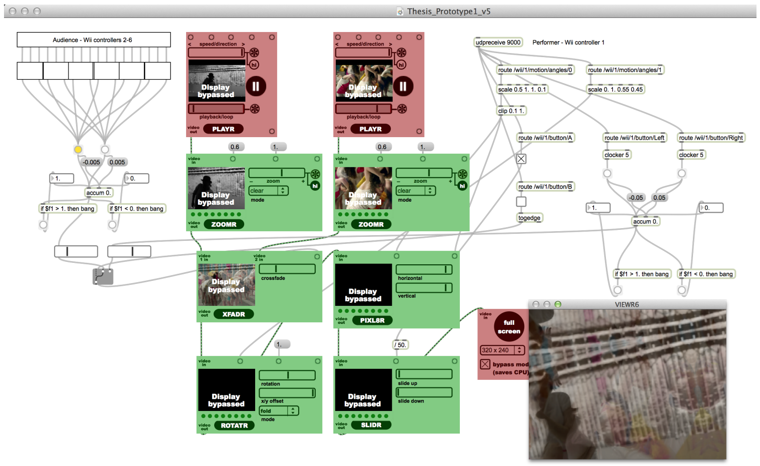


Figure 4.5: Prototype #1 Max patcher

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

4.1.3 Testing

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

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

4.1.4 Analysis

4.2 Prototype #2

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

4.2.1 Motivation

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

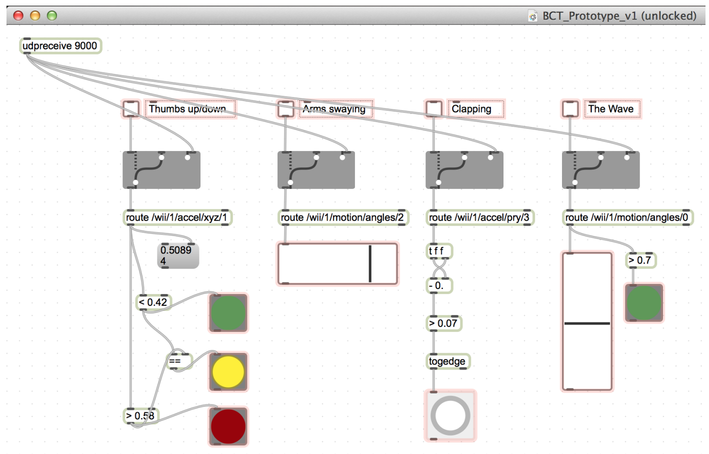


Figure 4.6: Monitoring thumbs up/down, arm swaying, clapping, and the wave

4.2.2 Development

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

Next, I modularized the previous patcher and multiplied it sevenfold. The actions of seven users could now be monitored simultaneously. I developed new visualizations to reflect these multiple inputs, shown in Figure **??**. 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.

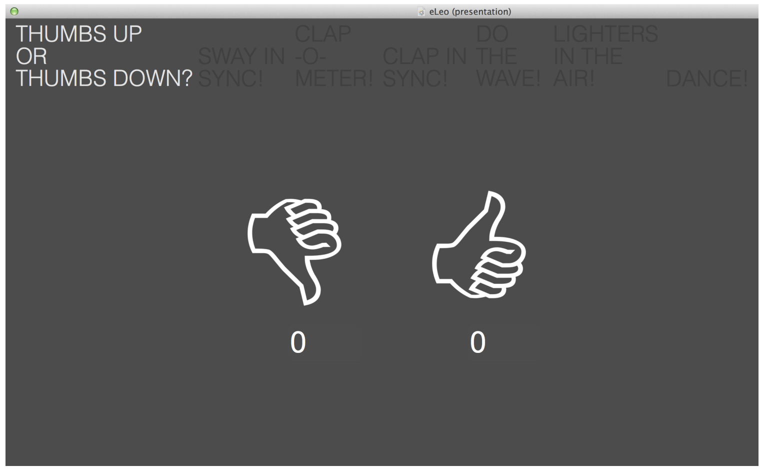


Figure 4.7: Input prompts

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

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

In preparation for the exhibition, I modified the patcher to function as an installation. An auto-play function was implemented; the input methods are looped through automatically, each activated for ten seconds at a time. A short text prompt is displayed to give users a hint at what action they should be performing (“Thumbs up or thumbs down?” “Sway in sync!” “Clap-o-meter!” “Clap in sync!” “Do the wave!” “Lighters in the air!” “Dance!”) as shown in Figure 4.7. Thus, the system would not require an operator, and users could approach it at any time during the exhibition and test each mechanic.

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

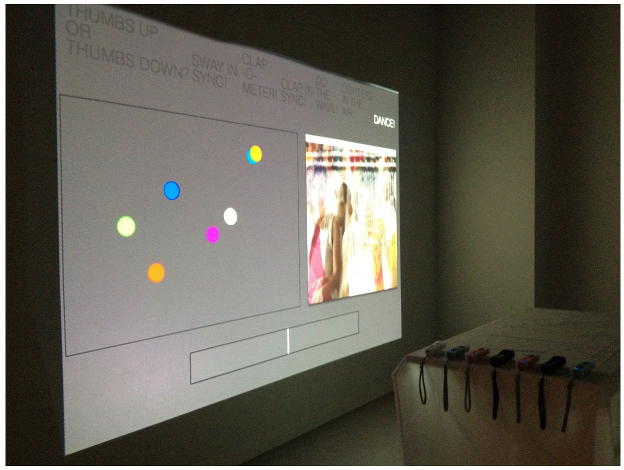


Figure 4.8: Prototype # 2 installed at the exhibition

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

4.2.3 Testing

Testing took place during the opening night of the exhibition. The final patcher was projected on a large wall in a darkened room using a short-throw projector. The seven Wii controllers were laid on a table in the middle of the room, their LEDs illuminated, inviting users to pick them up. Figure 4.8 shows the prototype set up in the exhibition.

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

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

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

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

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

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

Figure 4.9: Three users experiment with the prototype

the minor lag in the visualization was distracting.

Nearly all users instantly understood the prompt and were eager to raise their arms in the air. Figure 4.9 shows three participants performing the wave input. One group did not communicate and instead just watched their own slider, but most cooperated to raise their arms simultaneously. One group organized themselves in a row such that they were in the same order as their sliders on screen. Users enjoyed the appearance of this visualization. Although, a particularly thought-provoking comment was made by one user: this visual representation of the wave was less appealing than the wave itself.

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

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

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

4.2.4 Analysis

4.3 Prototype #3

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

4.3.1 Motivation

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

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

The band expressed interest in allowing the audience to control their light show in some way. Christian wanted a system that could unite audience members without turning into a distraction from the music. He also expressed concern about giving the audience too much control; only the band should be able to dictate the flow of the performance. Christian hoped that the technology would create a controlled environment that left some room for some spontaneity and uncertainty. My goal, then, was to develop a system that satisfied these wishes. However, it was important for design decisions to also be based in the knowledge gained from previous prototypes.

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

After presenting the initial concept to the band, some further adjustments were made. It was decided that hanging the lights from the keyboard would allow for the easiest setup and provide sufficient visibility to the crowd. Next, Christian and Molly expressed interest in being able to interact with the lights themselves. We agreed that it would be intriguing to design the lights such that the performers could pick them up; this could lead to unusual new interactions between audience and performer. Another point of discussion was how long the audience would be controlling the lights. The band and I both felt that the system

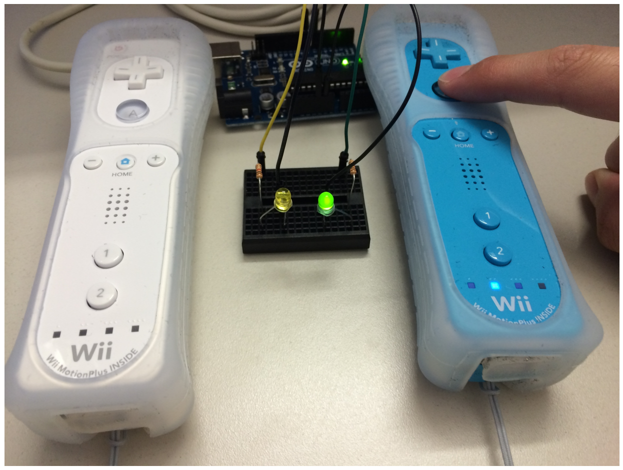


Figure 4.10: Turning on an LED with a Wii controller using Maxuino

should not be active for the whole performance, speculating that the audience would grow tired of it. We agreed to introduce the devices for the last two songs of the show. This would give the crowd sufficient time to warm up to the band and serve as a surprising finale. Rather than leaving the lights inactive, however, it was decided to incorporate them in a programmed light show until the audience was given control.

Figure X shows a diagram illustrating the system's functionality.

4.3.2 Development

The final prototype was built off of the reliable system 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 operate an array of lights. After installing a library called Maxuino[4], I was able to easily send instructions to the Arduino from the Max environment. As an initial test, I pulled button-press data from on Wii controller and connected the Arduino to an LED; I was successfully able to illuminate the LED by pressing the controller's A button, as shown in Figure 4.10.

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

Figure 4.11: Testing different types of lights

Tested incandescent bulbs; drew too much current and took too long to turn on. Tested bright LED lamp – requires 12 V, 100 mA each. Figure 4.11.

Made working relay circuit with LED lamps – Arduino switches TIP120s and turns lamps on and off. Made circuit with two relays and two LED arrays. Created Arduino sketch to alternate the arrays on and off. Acquired 12 V / 1 A power source and incorporated it into the circuit. Figure 4.12.

Made clap-operated lighting system using 3 Wii controllers and 3 LED arrays. Networked two MacBooks together through OSCulator to allow for up to 14 Wii controllers. Set up OSCulator routing; 6 Wii controllers on second MacBook send data to first MacBook over LAN; all connections both ways work as expected.

Replaced TIP120s with P2N2222A transistor – smaller, more available, still handles the current. Soldered LED control board. Installed in project box. Figure 4.13

Laser cut acrylic to make first prototype of light stand. Tested it with LED lamps. Laser cut second version of light stand x 4. Installed lamps and wire. Figure 4.14.

Incorporated enable/disable system for each lamp. Created light show programming system. Created a monitoring system in Max. Figure 4.15.

Removed vibration feedback for interaction portion. The latency was too high, possibly confusing. Carefully fine-tuned the input sensitivity, bounce delay.

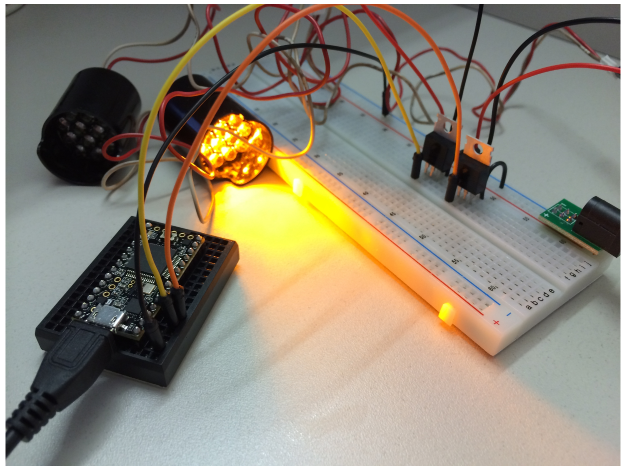


Figure 4.12: Operating two lamps using transistors and an Arduino

Made foam padding for Wii controllers to bury buttons. Taped up the controllers. Figure 4.16.

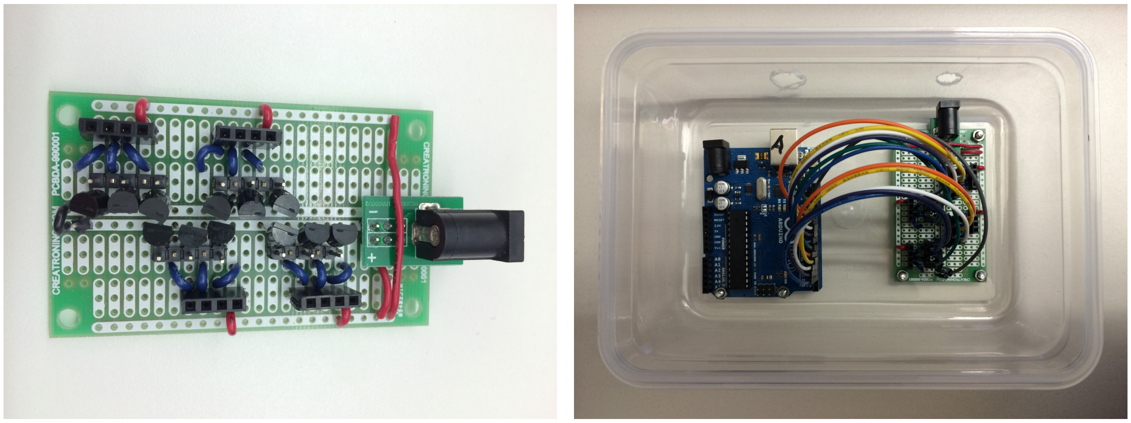
4.3.3 Testing

The prototype was tested at a performance at The Silver Dollar Room. Figure 4.17.

Audience

Performers

4.3.4 Analysis



(a) LED control board

(b) Board connected to Arduino Uno

Figure 4.13: Prototype #3 electronics

(a) Laser-cut acrylic

(b) Lamps and wire installed

Figure 4.14: Light stands

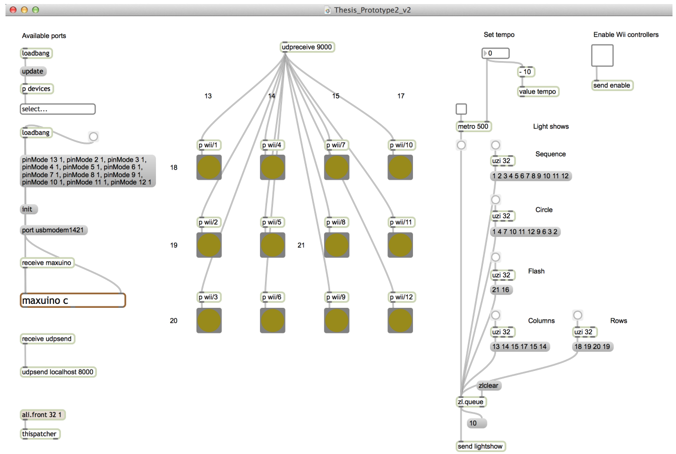
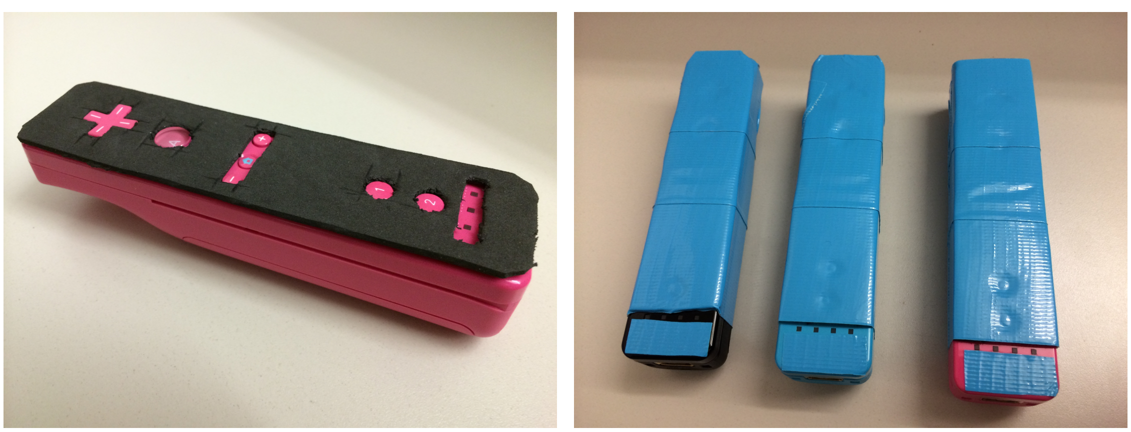


Figure 4.15: Control and monitoring in Max



(a) Controller with foam cover

(b) Taped controllers

Figure 4.16: Preparing the Wii controllers

Figure 4.17: The Silver Dollar Room

Chapter 5

Conclusion

5.1 Discussion

5.2 Future Directions

5.3 Conclusion

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