MOBILE PHONES, GROUP IMPROVISATION, AND MUSIC: TRENDS IN DIGITAL SOCIALIZED MUSIC-MAKING

by

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Abstract

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With the advent of the smartphone, the mobile phone has recently emerged as a popular choice for instrument designers. Mobile phones are computationally powerful, feature a rich suite of onboard sensors, have ever-increasing networking capabilities, are becoming easier to program, and are above all ubiquitous. Because of these factors and a solid marketplace for dissemination, designers have authored hundreds of musical instrument apps, steadily reaching public consciousness. As ubiquitous, handheld, networked instruments, mobile phones have properties that distinguish themselves from other digital musical instruments, and are uniquely positioned to have widespread cultural impact on how people make and share music. Still, the flexibility of configuration and lack of standardization makes it difficult to define what it means to 'play' a mobile phone.

In the first three chapters I attempt to locate mobile phone music in the broader historical context of electronic music, networked music, and the considerations of digital musical instrument design. Though the nascent field of mobile music-making is still emerging, the rapid evolution of devices, software, instrumental and cultural practices associated with this trend are in need of visibility and documentation. As such, I will trace the history of mobile

phone music as it has evolved from a ringtone-based art form to the smartphone era. My goal is to highlight various creative uses of mobile phones in musical contexts, including audience participation, locative art, mobile phone ensembles, and efforts to help everyday people feel empowered to express themselves through musical creation. I will also explore whether this ideal of democratizing musicianship has downsides, and how it impacts authorship and virtuosity.

The last two chapters cover my own contribution to mobile music, including the presentation of *4Quarters*, a software-plus-controller musical instrument for mobile phones and computer. As it is designed to be fundamentally collaborative and encourage improvisation, I will document its reception by test users and participants. *4Quarters* is available as supplemental material to this written dissertation. It is accessible as a downloadable standalone application, stored as a .dmg file, for Mac OS 10.4-7. It can be accessed at http://nb23.com/Diss/4Quarters%201.1.dmg.

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I wish to extend my sincerest thanks to my advisor, Prof. Douglas Geers, who has provided excellent and measured critique, always adhering to the highest standards of musical scholarship and academic literature. He has been exemplary in his communication and clear in

framing expectations throughout our many exchanges. I honestly cannot conceive of a better advisor in terms of encouragement, knowledge of the field, and generosity of time. I would also like to thank my reader, Prof. David Olan, for his sharp and honest feedback, which provided focus and help bring far more clarity to my writing than I could have produced on my own. I thank my committee members, Professors Peter Manuel and Dan Trueman, for their willingness to read my work and offer their guidance during the final stages of this entire process. Any errors or omissions that remain in this work are my own.

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INTRODUCTION

> *…We need to think carefully about how and when to automate, and how the players interface with this automation.*[1]

In digital musical instrument (DMI) design, the flexibility of configuration between hardware and software permits endless permutations. The mobile phone has proven to be a particularly flexible and popular choice of hardware for instrument designers. Given their ubiquity, increasing computational and networking power, and a marketplace for the dissemination of applications, mobile phones have been used as a central device for a flood of musical applications. Among instrument designers, a widespread appeal for using the mobile phone is the ability to grant non-musicians access to creative expression. The mobile phone's ubiquity and flexibility of configuration permits composition and performance for the masses. This is a main motivation for the instrument I present in this dissertation, *4Quarters*.

Still, with this host of various instruments and implementations, the lack of standardization has been prohibitive in defining the instrument in a cultural sense. What does it look like to play a mobile phone? How should it be held? How does one become proficient at mobile phone performance? Can mobile phones be played as a group? The answers to all these questions largely depend on how the software is configured, but there is a corollary to public perception as well.

With mobile phone instrument design, the relationship between the mechanism for producing sound and the body is arbitrary.[2] Yet a robust suite of onboard sensors can yield a physical experience with music-making in ways that other consumer electronics cannot, such as desktop and laptop computers. In Chapter 1 I will contextualize the effort to define the mobile phone as an instrument within the larger trend in digital musical instrument building, and the

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[1] Dan Trueman, "Why a Laptop Orchestra?" *Organized Sound* 12, no. 2 (2007): 175.
[2] Chris Brown, John Bischoff, and Tim Perkis, "Bringing Digital Music to Life," *Computer Music Journal* 20, no. 20 (1996): 29.

effort to reassert liveness and embodied performance into electronic music. I will address the following questions: How does the electronic music tradition address the problem of lacking a standard means of physical performance? To what extent do mobile phones address this problem? Does the use of metaphor help or hinder efforts to define the mobile phone as instrument? If automation can eliminate a need for disciplined training in musical performance, what are the ramifications for virtuosity? Is it possible to create low-entry level instruments for beginners and novice musicians while also paving ground for upward mobility and instrumental proficiency?

With *4Quarters* I propose to tie automation to the playback of samples, or performing other people's performances. This has been called 'schizophonic performance'.[3] I choose this form of automation for specific reasons: since I aim to leverage the ubiquity of mobile phones, it stands to reason to imbed widespread cultural practices into design. As such, in this chapter I explore how authorship and sampling practices have already been approached in several mobile apps. I discuss various ways in which musicians and digital music consumers deal with automation and pushing buttons: playlists, mashups, sampling, and remix.

In Chapter 2 I trace the history of mobile phones in music. As mobile phones are inherently networked devices, they belong to a longer history of networked music and art, and in many instances can be viewed as relatively new tools that simply extend well-formed aesthetic approaches to technology, geography, and social collaboration as it pertains to music. At the same time, mobile phone music—which at this point is roughly a decade old—is beginning to have a history of its own, with commentaries, frameworks, and ideas that are unique to the handheld devices. What are the ways that mobile phones disrupt the traditional paradigm of composer/performer/audience? When these roles are blurred or rearranged, what are the

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[3] This term is a derivation of R. Murray Schafer's term for the split between sound and its source, made possible by recording technology. See Kiri Miller, "Schizophonic Performance: Guitar Hero, Rock Band, and Virtual Virtuosity," *Journal of the Society for American Music* 3, no. 4 (2009): 401.

ramifications for managing expectations in a concert setting? How can participants quickly learn the affordances of a particular setup?[4] I will explore how and why many instrument builders have turned to game theory for answers in generating 'meaningful play.'

Chapter 3 focuses on using mobile phones as musical instruments. As a true convergence device, mobile phones today are closer to portable computers than simple telephony devices. The wide array of onboard features—sensors, networking functionality, and sound-generating components—combined with increasingly accessible software platforms have permitted mobile phones to be used as musical instruments, with increasingly sophisticated modalities for performance expression. In this chapter I will trace the paths in which the mobile phone has been used as an instrument: as a 'pocket' version of extant acoustic instruments, as a standalone instrument not modeled explicitly from instruments, and as networked instruments or controllers.

The 'mobility' of mobile phone music is being exploited both within and without the concert hall. How is musical space and place redefined as a result of these devices? In what ways have GPS technologies been explored in musical contexts? What is the current state of mobile ensembles and efforts to legitimize concert mobile phone performance?

With Chapters 1 through 3 providing context for design considerations, in Chapter 4 I present *4Quarters* in-depth. This is a software-plus-controller instrument expressly designed for collaborative composition and performance. The chapter contents will consist of a prose explanation of the features, layout, setup, and functionality of the instrument, followed by an overview of the code architecture. On the hardware side, the instrument requires a computer

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[4] I use the term 'affordances' as defined by Gaver and applied by Tanaka: "Affordances are properties of the world that make possible some action to an organism equipped to act in certain ways. ...Affordances then, are properties of the world defined with respect to people's interaction with it." Gaver, p. 80. William Gaver, "Technology Affordances," in *Proceedings of the CHI'91 Conference on Computer and Human Interaction*, New Orleans, USA, 1991, 79-84; Atau Tanaka, "Mapping Out Instruments, Affordances, and Mobiles," in *Proceedings of the International Conference on New Interfaces for Musical Expression (NIME 2010)*, Sydney, Australia, 15-18.

and several iPhone/iTouch devices, but here I present the software as a downloadable standalone desktop application along with companion application layouts for mobile phones.

Chapter 5 will be a presentation on the results and feedback garnered from performances and installations using *4Quarters*. I aim to learn how the software tends to be used by musicians and non-musicians, detailing the strengths and weaknesses of the instrument as a prototype. This will inform further revisions and developmental steps down the road. A conclusion will address both my contribution to the mobile music and the overall outlook of this nascent and emerging field.

CHAPTER 1. PUSHING BUTTONS: SCHIZOPHONIA IN DIGITAL MUSIC

With mobile phone instrument design, the relationship between the mechanism for producing sound and the body is arbitrary, which is both a blessing and a curse for establishing the mobile phone as a musical instrument. In this chapter I will contextualize the effort to define the mobile phone as an instrument within the larger trend in digital musical instrument building, and the effort to reassert liveness and embodied performance into electronic music. In my own attempt to leverage the ubiquity of mobile phones, I propose the inclusion of widespread cultural compositional practices—remix, sampling, and an inherent bias toward looping ostinatos—within the instrument I present in this dissertation, *4Quarters*.

Before discussing trends of mobile instrument design in-depth, a short summary of *4Quarters* will help frame the chapter. In brief, *4Quarters* is a multiplayer software-plus-controller instrument designed for both casual performance settings—jam sessions in living rooms—as well as formal concert performance scenarios involving audiences.[5] It functions as a sampler that permits multiple sound files to be loaded into computer memory, and then played back in real time. A central feature of the instrument is the open architecture for loading prepared or pre-composed sound files into the instrument, thus inviting a wide array of compositional approaches.

From a performance perspective, currently the main control parameters available to a performer are: 1) sound file selection (one player can choose between twelve files at any given time, and choose to play one at a time or several at once); 2) bank selection (five separate banks of twelve files can be interchangeably loaded for playback); 3) looping; 4) volume (overall volume and individual levels for each sound file); 5) panning; and 6) equalization control (EQ).

[5] These two orientations—casual performance for novices and serious concert performance for dedicated composers and advanced performers—can raise issues that are at times mutually exclusive. For instance, if *4Quarters* is played among friends in a private setting, audience communication issues are not a concern. I will nonetheless address performance and compositional concerns as they pertain to both formal and informal uses of *4Quarters*.

As the design of this instrument is primarily aimed to cater to novice musicians, these parameters were chosen because they are common controls on many consumer audio devices. Additional control parameters may be added in future iterations of the instrument, particularly as upward mobility for virtuosic performance is addressed.

1.1 Non-corporal vs. physical performance in the computer music tradition

1.1.1 Introduction

For many historical and social reasons, music-making by physical gesture is something that many people enjoy doing and watching. As real-time computer music has become viable, many within the field of electronic music have shifted focus to how to make computer instruments physically engaging. Computer musicians are seeking ways to make this happen satisfactorily with instruments that are essentially software-plus-controllers. Phones are a type of controller that has recently become much more interesting because (1) they are now general purpose computers in addition to telephones, (2) they typically offer multiple sensors and interfaces that permit physical input, and (3) they are in the pockets of billions of humans. In this first section I will address the issues that have arisen from designing new instruments for musical performance: communicating cause and effect to audiences, dealing with a lack of standardization of mapping procedures and gestures, and the role of metaphor in defining new instruments in ways that are collectively understood by performers and audiences. Many of these core issues are not new to mobile phone instrumental design, but are particularly relevant with a device that is inherently known for other functions.

1.1.2 Communicating Cause and Effect in Performance

Historically, the variety of formats of presentation in electroacoustic music has at times created tensions in performer/audience interaction, and the lessons learned along the way have informed current trends in physical computer music. For instance, ‘tape’ pieces and works for

automated synthesizers realized on stage with a composer merely hitting the play button have led to questions about who or what the performer is. Without an embodied performer on stage, and with concert halls traditionally situated for *some* sort of visual stimulus to take place, the lack of visual cues began to raise an awareness of the performer's contribution in communicating with the audience. A performer's expressiveness can greatly affect the audience's perception of form, surprise, and mood.[6] It seems logical that composers quickly adapted to create works for live acoustic instruments and fixed media playback as a way of exploiting the creative possibilities of magnetic tape while also maintaining a connection to physical human performance. As personal computers became more affordable and computationally more powerful, many composers began viewing the computer as a viable real-time performance instrument, particularly because they typically featured several sensory inputs built-in. The two most obvious means for input—the qwerty keyboard and mouse—allow for a great range of options from the performer's perspective, but the physical movements needed to control these do not translate well in informing audiences of the physical connection between performer and sonic output.[7] If nothing is done on the part of the performer to associate his/her actions with the sonic output—even if the music relies on live performer input—, then to the audience the performance may look no different than someone checking his/her email.[8] To compensate for performances where physical input is limited or difficult to see, other factors have been introduced, such as the overly-dramatized keypress, head bobbing, dancing, projected

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[6] A performer also helps audiences discriminate between sounds that belong to the piece vs. unwanted sounds from the environment in which the piece takes place. If, for example, a *musique concrète* piece featuring a great variety of found sounds is played over loudspeakers, and an audience member's phone interrupts, it may be difficult to discern whether the sound of the phone is part of the piece.

[7] Ben Neill, "Pleasure Beats: Rhythm and the Aesthetics of Current Electronic Music," *Leonardo Music Journal* 12 (2002): 3-6.

[8] At the 1st Symposium for Laptop Ensembles and Orchestras (Louisiana State University, 2012) this phenomenon was discussed throughout the conference, and was dubbed the 'email syndrome.' See also John Gibson, "Wind Farm, a Composition for Laptop Ensemble," in *Proceedings of the 1st Symposium on Laptop Ensembles & Orchestras (SLEO)*, Baton Rouge, 2012, 3.

visuals drawing attention away from what the performer is doing, or projecting the performer's own computer screen. Another alternative measure is to forego the use of keyboard and mouse input in favor of other controllers that can interface easily with a computer but afford larger gestural movement. Of course, the tactics used to deal with gestures too small for the audience to see are not unique to electronic instruments. A clarinetist's change of fingerings, for example, may also be too subtle for the audience to notice. Any instrumentalist wishing to communicate to the audience must develop a way to relate the connection between physical exertion and sonic outcome. The aspect that separates digital musical instruments (DMIs) from traditional acoustic instruments and their accompanying performance traditions is physical flexibility afforded through various configurations.

1.1.3 Lack of Standardization in Mapping and Gestures

While the abundance of options has led to an explosion of creative work in interactive computer music, there is a lack of standardized performance practices.[9] This creates several opportunities for the composer, but also several problems. On the one hand, the composer is free to design not only the instruments, but also the actions by which they are performed and the resulting sounds, and is therefore responsible for determining the interactions between conductor (if there is one), performers, and score.[10] On the other hand, in considering the audience's understanding of the performance, a lack of standardized gestures means that a language will need to be established to help educate the audience about what is going on.[11] A set of standardized gestures then becomes very desirable, even within the realm of "experimental"

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[9]It is tempting to look for similarities based on controllers, but two pieces both using motion capture techniques, for example, may be so different in musical character, use of visual data, performance space, and performance techniques, that the only unifying element is that they rely on cameras for data input.

[10] Luke Dahl and Ge Wang, "Sound Bounce: Physical Metaphors in Designing Mobile Music Performance," in *Proceedings of the 2010 Conference on New Interfaces for Musical Expression (NIME 2010)*, Sydney, Australia, 2010, 178-181.

[11] W. Andrew Schloss, "Using Contemporary Technology in Live Performance: The Dilemma of the Performer," *Journal of New Music Research* 32, no. 3 (2003): 239-242.

music. This becomes especially relevant when the given controller is typically used for other non-musical purposes—as it is with the phone. The performance use needs to overcome the barrier of default expectations. In order to do so and avoid becoming a gimmick, the phone needs to do something that cannot be done just as easily with a conventional instrument. The problem then becomes how to reconcile these new instruments that do not follow the "rules" of conventional acoustic instruments to the social experience of music, in which audiences' understanding is largely based on a long-standing tradition of how music is made: by striking, plucking, rubbing, or blowing.[12] In grappling with this issue over the course of several years of trial and error, W. Andrew Schloss outlined several "best practices" when composing with DMIs:

1. Cause-and-effect is important, at least for the observer/audience in a live concert venue.
2. Corollary: Magic in a performance is good. Too much magic is fatal! (Boring).
3. A visual component is essential to the audience, such that there is a visual display of input parameters/gestures. The gestural aspect of the sound becomes easier to experience.
4. Subtlety is important. Huge gestures are easily visible from far away, which is nice, but they are cartoon-movements compared to playing a musical instrument.
5. Effort is important. In this regard, we are handicapped in computer music performance.
6. Improvisation on stage is good, but "baby-sitting" the apparatus on stage is not improvisation, it is editing. It is probably more appropriate to do this either in the studio before the concert, or if at the concert, then at the console in the middle or back of the concert hall.
7. People who perform should be performers. A computer music concert is not an excuse/opportunity for a computer programmer to finally be on stage. Does his/her presence enhance the performance or hinder it?[13]

Schloss's conclusions touch on a variety of aspects of design, and some of these items will be discussed in detail later. Of importance here is the focus on audience engagement and communication.

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[12] Perry Cook, *Real Sound Synthesis for Interactive Applications*, (Natik, MA: A.K. Peters, 2002), xiii.
[13] Schloss, "Contemporary Technology in Live Performance," 242.

1.1.4 Defining the Instrument through Metaphor

In lieu of standardization, metaphors have occasionally been used as a means to help performers and audiences quickly learn what is going on in a given interactive piece. Metaphors are heavily used in the mobile app domain, particularly because the function of an app must be quickly understood in order to distinguish it from an ever-increasing supply of alternatives in mobile app marketplaces. Yet these attempts to implement metaphors have had mixed results. Here I will draw attention to three types of metaphor: (1) controllers mimicking extant analog or acoustic instruments, (2) cultural metaphors designed to situate a performance in a particular setting, and (3) games. Some of the following examples incorporate all three of these types of metaphors.

The first type of metaphor, and perhaps most common, is to mimic extant analog or acoustic instruments with so-called 'pocket' versions for mobile phones.[14] In general, these slimmed-down instruments tend to emphasize convenience and portability over potential for actual live performance. Pocket piano and guitar apps fall into this category – fewer keys or frets are immediately available, but these apps might help a music fundamentals student figure out intervals. In some instances, however analog/acoustic instruments are mimicked but then augmented instead of reduced. One of the most popular iPhone music apps, Smule's *Ocarina*, falls into the latter category.[15] I would like to focus on this app because the metaphor of the ocarina is used as a vehicle for introducing fundamentally unique features offered by mobile devices.

Smule's *Ocarina*, created by Ge Wang and Jeff Smith, is designed for mass appeal. With its sparse layout, use of the mic for blowing, and eponymous name, one can intuitively figure out

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[14] Most apps that mimic other instruments quickly become relegated as cheap imitations of the real thing. In asserting the viability and validity of using the phone as a DMI, designers must leverage the phone in ways that go beyond novelty. The growing number of research articles devoted to new mobile interfaces is substantiating this viewpoint.

[15] Smule's *Ocarina* is advertised as 'One of Apple's *All-Time Top 20 Apps*.' "Ocarina 2 by Smule – Experience Social Music," accessed December 19, 2011, http://www.smule.com/ocarina/.

how the mobile phone is transformed into a simulated acoustic ocarina. In order to make music, the phone must be physically handled in an orientation completely different than when talking on the phone. When launching the application, the concept of how to play is easy to grasp: four buttons are displayed, and an arrow flashes with the message "blow into the mic". The ease of use and its broad accessibility is confirmed by Wang's observation that most users are not musicians.[16] Smule's *Ocarina* borrows from the extant English pendant ocarina heavily; this is reflected in its four-hole layout, one-octave pitch register, and *Ocarina*'s reliance on breath to make sound. Yet the instrument includes several features that distinguish it from its acoustic predecessor. First, certain physical limitations are easily transcended digitally: rather than being limited to one key or scale based on the size, shape, and thickness of the clay, one can swap out modes and tonal centers to play different scales, and can customize fingers for up to 16 different combinations. The digital ocarina ensures precise tuning and consistent sound quality without dealing with partially uncovered holes.[17] Vibrato can also be applied depending on the angle at which the phone is held: the onboard accelerometer up-down tilt is mapped to vibrato depth, while left-right tilt is mapped to vibrato rate. A second significant feature included in Smule's ocarina is the recording capability. One can record melodies and seamlessly upload them online via email. The automated email message is geared toward sharing the created track with others, suggesting that the app can be used for social purposes even if the recording was made in isolation. This orientation toward online sharing is one of Smule's main design goals. Perhaps the most important feature of the ocarina is *World Listener* view, which leverages GPS (Global Positioning System) location data to allow other users across the globe to hear what you are playing, and visa versa. This particular aspect leverages the notion 'locative media' as described by Gaye et al., which is concerned with musical interaction in mobile settings, using

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[16] Ge Wang, "Designing Smule's iPhone Ocarina," in *Proceedings of the 2009 Conference on New Interfaces for Musical Expression (NIME 2009)*, Pittsburgh, USA, 2009, 303-07.
[17] This sort of uniformity is of course not necessarily considered an upgrade, particularly if subtle intonation inconsistencies and timbral deviations based on hole coverings are desirable.

portable technology.[18] Because of this particular aspect of engagement in a global community—even if that engagement is purely on a surface level—the app is not merely a gimmicky imitation of a 'real' instrument. The mobile phone is a new instrument in its own right, permitting fundamentally new kinds of musical interaction.

The second type of metaphor is the use of cultural metaphor to situate an instrument into a given cultural setting. Perhaps the most successful and polarizing implementations of controllers in situated cultural formats are *Guitar Hero* and *Rock Band*, initially launched by Harmonix Music Systems in 2005 and 2007, respectively.[19] Both of these games are sight-reading games that reward players according to their ability to execute a series of button presses within the given tempo and rhythms of a song. Songs are 'played' successfully when a user executes button pushes within the correct timeframe. While both video games have 'pocket' versions as mobile apps, the games are predominantly renowned for their use of guitar-shaped controllers. But the metaphor extends far beyond the shape of the controller. As a player in the game, one becomes a virtual member of a live concert rock band. Heroism, machismo, and virtuosity—all ideals associated with Rock n Roll—are reinforced in gameplay through competition, the rock-based style of the graphics, and the body language of the on-screen avatars. Virtual crowds cheer or boo the avatars, depending on how successful a player hits buttons at the right time. A point system rewards players for accuracy in following the musical score, with higher scores leading to the band playing in bigger and better venues. All of these game characteristics help orient the player and essentially direct them in what to do. By coupling the element of competition with the free spirited nature of Rock n Roll, these games empower players to make music with flair. The implied message of the games is that not only

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[18] Lalya Gaye, Lars Erik Holmquist, Frauke Behrendt, and Atau Tanaka, "Mobile Music Technology: Report on an Emerging Community," in *Proceedings of the 2006 Conference on New Interfaces for Musical Expression (NIME06)*, Paris, France, 2006, 22-25.
[19] Harmonix Music Systems, *Guitar Hero*, video game, Sunnyvale, CA: Red Octane, 2005; Harmonix Music Systems, *Rock Band*, video game, Redwood City, CA: Electronic Arts, 2007. Activision Publishing, Inc currently owns both video games.

should players strap on the guitar controller and try to get a high score, but that they should let loose and think of themselves as rock stars.[20]

It is one thing to educate a player on how to engage with a video game environment such as Guitar Hero. It is an entirely different thing to educate an audience about the structure, form, and intent of a newly composed concert piece for mobile phones. For instance, in self-delectating performance—be it video games or implementations of *4Quarters* in private settings—the need to establish meaningful gestural controls is not as consequential as it is in the concert paradigm. Physical gestures in concert take on more significance due the necessity to establish performer-audience communication and performance presence. In a situation where mobile phones are used in an unfamiliar way, a context must be created, particularly when there is no standardization in performance practice with mobile phones. The cultural metaphor used in Nicholas J. Bryan's iPhone ensemble piece *Wind Chimes* (2010) for Stanford University Mobile Phone Orchestra (MoPhO) is implicit in the title.[21] Performers blow into the iPhone microphones by standing in the middle of the audience, triggering simulated wind chimes in the 8-channel open system in the direction the performer is facing. The audience is intuitively engaged because of the simplicity of the connection between gesture and sound. Directionality, blowing and its association with wind, the easily recognizable situated sound of wind chimes, and the fact that wind chimes respond in a fairly clear representational matter to the magnitude of the wind all help teach the audience—very quickly—how the mobile phone is an instrument.

The third type of metaphor—gaming—is frequently employed to educate an audience about what performers are doing has been a moderately successful strategy in mobile music thus far. In *Sound Bounce* (2010) written for Stanford University's MoPhO, Luke Dahl uses the metaphor of throwing and catching a ball between iPhones to instill the audience with a sense of

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[20] Kiri Miller, "Schizophonic Performance: Guitar Hero, Rock Band, and Virtual Virtuosity," *Journal of the Society for American Music* 3, no. 4 (2009): 423.
[21] Jieun Oh, Jorge Herrera, Nicholas J. Bryan, Luke Dahl, and Ge Wang, "Evolving the Mobile Phone Orchestra," in *Proceedings of the 2010 Conference on New Interfaces for Musical Expression (NIME 2010)*, Sydney, Australia, 2010, 86-87.

drama and anticipation.[22] Performers "play" with sound by tossing it back and forth and try to "keep it going". The bouncing ball has its own simulated physics, and is put in play through gesture with the iPhone. Each player runs the risk of dropping the ball, which means elimination from the contest. Specific sounds correspond to a successful catch, the flight of the ball (higher elevation is matched by higher pitch), and a botched catch. The winner is the last person still making a sound. The familiar real-life game scenario allows audience members to map personal experience onto a new unfamiliar one, and part of the drama becomes the confirmation of how that experience is played out in a musical context.

Overall, there is a clear sensitivity to audience communication reflected in these newly formed mobile ensembles and instruments. In the case of using the mobile phone as an instrument in a concert setting, the musical function (and its legitimacy as a new instrument) must be made clear to both the performer and the audience. Two recent papers—also from Stanford—suggest that this transition is no small task. Gurevich, Verplank, and Wilson developed curriculum at Stanford University's Center for Computer Research in Music and Acoustics (CCRMA) to address physical interaction design for music.[23] As designers grapple with translating physical gestures into sound, Bruno Ruviaro notes the importance of focusing on the human body *as shaped by a particular instrument* (the presence of an instrument).[24] Not only does the designer need to define the capabilities of the instrument, but s/he must also realize that performative success depends on how clearly the range of movements is defined for performers so that the audience can connect gesture (cause) to sonic outcome (effect). According to Ruviaro, a significant milestone for an instrument's design is the ability for an audience to notice performative mistakes. In the case of all of the aforementioned examples—

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[22] Dahl and Wang, "Sound Bounce," 179.
[23] Michael Gurevich, Bill Verplank, and Scott Wilson, "Physical Interaction Design for Music," in *Proceedings of the International Computer Music Conference (ICMC)*, Montreal, Canada, 2003.
[24] Bruno Ruviaro, "From Schaeffer to *LOrks: An Expanded Definition of Musical Instrument in the Context of Laptop Orchestras," in *Proceedings of the 1st Symposium on Laptop Ensembles & Orchestras (SLEO)*, Baton Rouge, USA, 2012, 23-26.

Ocarina, *Rock Band/Guitar Hero*, *Wind Chimes*, and *Sound Bounce*, the performer's range of motions and their resulting sounds are defined well enough that an audience can detect when something goes wrong. For instance, when a player in *Guitar Hero* misses a note on the score, a 'mistake' audio file plays, sounding like a poorly executed guitar strum. In *Sound Bounce* a dropped ball is signaled by a 'game over' sound closely associated with video games.

1.1.5 Negative Effects of Metaphors

While these examples highlight relatively successful scenarios where the performer-audience connection has easily clicked, there are several instances where metaphors have undesirable side effects. For instance, some newly developed electronic instruments borrow so heavily from extant instruments in their design or performance tradition that one might wonder what sort of improvements the electronic or digital version offers over the acoustic or analog predecessor. The act of emulation frequently makes performers feel that the new instrument is not as good as the "real thing." This has direct bearing on whether *4Quarters* might be called an instrument as opposed to an environment. The following examples illustrate how the associations of extant instruments might backfire. The St. Lawrence String Quartet used the *Magic Fiddle* for iPad and noticed a lack of tactile feedback that is part of the bowed instrument experience.[25] In assessing current practices and opinions surrounding popular games *Rock Band* and *Guitar Hero*, Kiri Miller outlines the strong division of opinions about whether playing the games with their accompanying controllers can constitute playing 'real' instruments, since they clearly and deliberately imitate extant instruments.[26] Because the *Rock Band/Guitar Hero* guitar controller has only five binary buttons in place of frets and a binary strumming switch, many argue that the coordination and discipline required to perform in *Guitar Hero* pales in comparison to the dedication necessary to play a guitar with frets and strings, which

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[25] Ge Wang, Jieun Oh, and Tom Lieber, "Designing for the iPad: Magic Fiddle," in in *Proceedings of the International Conference on New Interfaces for Musical Expression*, Oslo, Norway, 2011, 197-202.
[26] Miller, "Schizophonic Performance," 419.

includes a mastery of a wider range of parameters: timbre, volume, tone, rhythm, etc. In reality, the actual architecture of a *Guitar Hero* controller and a guitar bear little resemblance beyond the shape. But because the history, cultural icons, and associations are tied together by design, the legitimacy of the new instrument is immediately viewed in contrast to the longstanding tradition of the guitar.

A separate aspect of *Guitar Hero*, its goal-oriented framework, has had a residual effect on similar mainstream music apps and DMIs. In assessing user feedback for the iPhone app *ZooZBeat*, Weinberg et al. (2009) found that many users found the app to be 'pointless' since there was no gaming metaphor to guide performer actions.[27] The goal of producing satisfying music was not clear due to the app's lack of structure. So the precedent of one familiar app may frame the expectations of another because, in learning what a new instrument does, users tend to look for associations of other DMIs to provide context in their first encounters with the instrument.

1.1.6 Metaphors in *4Quarters*

With all of these precedents now given as context, I will shift the discussion to discuss the software and controller design of *4Quarters*, the instrument/compositional tool I present in this dissertation in fulfillment of the requirements for presenting substantial compositional work. Like many instrument designers currently working with mobile phones, I aim to make use of the unique qualities of mobile phones and leverage these qualities to find novel approaches to ensemble interaction that cannot be achieved in traditional acoustic means. In this introduction I will focus primarily on cause and effect, audience communication, and the types of metaphors I employ. Though I will briefly mention the physical input and range of movements available in playing this instrument, these aspects will be discussed in detail in

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[27] Gil Weinberg, Andrew Beck, and Mark Godfrey, "ZooZBeat: a Gesture-based Mobile Music Studio," in *Proceedings of the International Conference on New Interfaces for Musical Expression (NIME09)*, Pittsburgh, USA, 2009, 315.

section 3.2, *Mobile Phones as Instruments*. Other key design features and architecture will be discussed in Chapter 4.

Bearing in mind that cause and effect is both a visual and sonic aspect of musical performance, I set out to design a scenario where performers and audience can be able to have a visual connection to every sound made, and that all activities by the ensemble can be seen at any given time.[28] Similar to *3001: Massively Multiplayer Musical Instrument* (2007) by Joshua Knowles and Joo Youn Paek and the games *Guitar Hero* and *Rock Band*, a visual projection shows all participants' activities.[29] Phones serve only as controllers: any user input on a phone is sent to a central server, where the sound is processed and handled. In this sense the metaphor of a remote control to a TV is useful in framing how physical input controls sonic and visual stimuli. Outgoing messages from the phones control the following sonic parameters: sound file selection, looping, volume, panning, and equalization (EQ). These messages each have a corresponding visual indication on a projected screen that can be seen by all participants. Multiple players can influence and shape one 'layer' of sound, and their activity is visually delineated by color.[30] So 'team red' may have one person in charge of sound file selection, another person controlling volume, and a third person shaping the EQ. The physical range of motions available in 'playing the instrument' fall into three main categories: players press buttons, move sliders, and move the phone using built-in accelerometers to affect sounds. Because most input comes through touching the phone screen or pushing buttons, the performer would need to add dramatized motions to translate these activities to the audience; but nevertheless both performers and audience can 'see' the performance take place on the

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[28] See Martin Blain, "Issues in Instrumental Design: the Ontological Problem (Opportunity?) of 'Liveness' for a Laptop Ensemble," in *Proceedings of the 1st Symposium on Laptop Ensembles and Orchestras (SLEO)*, Baton Rouge, USA, 2012, 63-71.
[29] Joshua Knowles and Joo Youn Paek, "3001: Collaborative Musical Gameplay," 2007, accessed October 13, 2012, http://www.auscillate.com/mmmi/.
[30] This is a key feature enabled through a network ensemble that distinguishes it from traditional ensembles. With perhaps the exception of John Cage's *Imaginary Landscape No. 4* (1951), where two players would play one radio in tandem, there are few instances where teams of performers are in control of one sound.

screen. Any sound file selected has a corresponding button that becomes highlighted on the screen, and an accompanying waveform diagram has a scrollbar that indicates progress of the sound's looping playback over time. Volume, panning, and equalization can all be controlled by accelerometer; and so these parameters tend to garner more obvious physical movements that easily connect a performer to the visual projection.

In terms of connecting a certain 'liveness' of performance to the audience, a design flaw is made bare in the physical positioning of performers relative to the screen projection. Players naturally want to look at their phones as well as the main screen to handle issues of synchronicity in particular. But that has ramifications for a performance space in which the stage is situated to have performers facing the audience. In the case of *4Quarters*, everyone tends to watch the screen, as it is 'where the action is'. An experienced performer would need to move beyond the tendency to look down at his/her phone if s/he hopes to establish a presence apart from the visual projection. This of course is only relevant if *4Quarters* is to be used in a traditional concert venue setup, when in fact this instrument may be best suited to casual playing situations, such as in one's living room. One possible remedy for the concert setup is to have a second projection behind the audience for the players to watch, or a smaller screen facing them onstage to lessen the "everyone watching screen at back of stage" problem.

The initial visual design was shaped by the metaphor of the familiar twelve-key interface found on touch-tone phones and still maintained on mobile phones. Thus the real instrument metaphor driving the visual layout of *4Quarters* turned out to be the mobile phone itself. Various types of assignments were conceived to work with the twelve-key tactile interface. Preliminarily I planned for multiple phones to communicate keypresses to one central server, with all sound processing occurring on that server. Participants would link in by dialing a phone number, and dual-tone multi-frequency (DTMF, or touchtone) keypresses would be captured via the telephony platform *Asterisk*, which would then route the data to the software instrument I

created with the application *Max/MSP*.[31] After smartphones arrived and became widely used, I was able to consider additional metaphors because of their increased capabilities. Hence, the metaphors used in *4Quarters* are primarily tied to things associated with the range of motion the phone tends to accommodate, and visual metaphors are deliberately employed to reinforce how a phone interface typically looks. If the phone in use has a built-in accelerometer, twisting the phone either to the left or the right controls panning in a stereo image. Moving the phone up and down vertically corresponds to moving the volume up and down. Controlling the peak frequency and Q (slope of frequency attenuation) of the EQ uses the same x- and y-axes as volume and panning.

In its current form, the architecture of *4Quarters* comes closest in design and function to a push-button sampler. Performance consists of controlling playback and manipulation of prerecorded audio files. Depending on the performance constraints of the server computer's RAM, the audio files that lead to the most successful performances tend to be short in length and loopable. As with any sampler, a staggering variety of timbres and sounds can be loaded and ready-at-hand for performers to then play in any order. This has tremendous ramifications for the type of performance that the instrument permits and to what extent it permits expressiveness and/or virtuosity. This also raises some complicated issues about authorship if multiple composers' sound files are loaded into the palette of choices made available to the performer(s).

Ruviaro noted that a significant benchmark in an instruments' development is whether performative mistakes can occur and be noticed by audience.[32] In the next section, I will add a second significant benchmark for an instrument's development: that it can permit virtuosity.

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[31] Asterisk is an open source framework that allows one to configure a computer to serve as a communications server, essentially merging telephone networks with general-purpose computers. See Digium, Inc., *Asterisk*, 2013, accessed February 27, 2013, http://www.asterisk.org; Cycling74, *Max/MSP*, 2013, accessed February 27, 2013, http://cycling74.com.

[32] Ruviaro, "From Schaeffer to *LOrks," 24.

1.2 Concepts of Virtuosity in Composition, Performance, and Gaming

1.2.1 Introduction

Prosper the Amateurs! -*J.N. Burk*[33]

4Quarters is a digital musical instrument designed to allow people who do not consider themselves musicians to make virtuosic sounds at the push of a button, where the sounds themselves are pre-recorded audio of musical performances. This mode of music-making could be potentially powerful in forming a new performance practice for novice musicians, but it creates a conundrum: if a person only has to push a button to make *virtuosic* sounds—that is, sounds that are physically very demanding for a human to create and imply hundreds or even thousands of hours of dedicated practice to be able to execute—then is there any virtuosity on display? Since the act of pressing the button to play a musical recording seems antithetical to the instrumental mastery required to perform one of Luciano Berio's *Sequenzas*, for example, one might argue that it actually implies anti-virtuosity. But what if the act of pressing a button to play a recorded performance is thought of as a creative act or performance in its own right (as is the case with *4Quarters*)? How frequently would one need to press buttons for the exercise to become a performance? If it is a performance, is it then best described as a form of meta-virtuosity or a faux-virtuosity? Furthermore, could one become a virtuoso at displaying faux-virtuosity? All of these questions essentially relate to automation and the extent to which human effort is required for performance. With digital musical instruments (DMIs), these two variables can take form in a wide array of configurations.

In the case of automated playback, its most common format, this type of disconnection between physical, visceral music-making and pressing 'play' occurs millions of times per day, and has troubled many scholars and musicians since the beginning of sound recording technology. John Phillip Sousa warned in "The Menace of Mechanical Music" that automated

[33] J.N. Burk, "The Fetish of Virtuosity," *The Musical Quarterly* 4, no. 2 (1918), 288.

playback (or 'canned music,' as he called it) could choke musical creativity.[34] In 1969 R. Murray Schafer likened the separation of sounds from the corporeal movements that created them to a technological disease, diagnosing it 'schizophonia.'[35] Today scholars have described the experience in friendlier terms—in part because the separation between source and sound is now such a common experience—, shifting the focus away from calling technological sound reproduction a *dissociation* of sound from its original source to such things as a *transduction*, *alteration* (Sterne 2003), or a *mediatized* form of performance (Auslander 2008).[36] Perhaps because our listening and performing experiences have been so profoundly influenced by technology in the early twenty-first century, and because the technology has been in such a constant state of flux, it is difficult to pinpoint how music technology changes our interpretation of what it means to be a musician.[37] Here I will explore what it means to be a virtuoso in the 21st century, what it means to be an amateur, and how these social positions relate to physical performance, composition, and/or computer fluency, particularly as it relates to mobile phone instrument design. A new type of amateur musicianship has coincided with a democratization

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[34] In Lawrence Lessig's TED Talk "Laws that Choke Creativity" (2007), which was an excerpt from his book *Remix: Making Art and Commerce Thrive in a Hybrid Economy* (2008), Lessig couches Sousa's stance in modern terminology, saying that Sousa feared a 'read/write' culture was on the verge of becoming a 'read-only' culture. Lessig says: "Now, as you look back at the twentieth century, at least in what we think of as the, quote, 'developed world' –hard not to conclude that Sousa was right. Never before in the history of human culture had it been as professionalized, never before as concentrated. Never before has creativity of the millions been as effectively displaced, and displaced because of these, quote, 'infernal machines' [the phonograph]. The twentieth century was that century where, at least for those places we know the best, culture moved from this read-write to read-only existence." John Phillip Sousa, "The Menace of Mechanical Music," *Appleton's Magazine* 8 (1906), 278-284; Larry Lessig, "Larry Lessig Says the Law is Strangling Creativity," filmed March 2007, TEDvideo, 18:59, posted November 2007, accessed February 28, 2013, http://www.ted.com/talks/larry_lessig_says_the_law_is_strangling_creativity.html.

[35] R.M. Schafer, *The New Soundscape: A Handbook for the Modern Music Teacher* (Don Milles, Ont.: BMI Canada, 1969), 42; Pedro Peixoto Ferreira, "When Sound Meets Movement: Performance in Electronic Dance Music," *Leonardo Music Journal* 18 (2008), 18.

[36] Jonathan Sterne, *The Audible Past: Cultural Origins of Sound Reproduction* (Durham, NC: Duke University Press, 2003), 132; Philip Auslander, *Liveness: Performance in a Mediatized Culture* (New York: Routledge, 2008), 4-5.

[37] William Duckworth, *Virtual Music: How the Web Got Wired for Sound* (New York: Routledge, 2005), xv.

of computer music tools such as the digital audio workstation (DAW) and music-centric video games, which will be discussed. Here I use Lessig's meaning of amateur culture:

> ...I don't mean amateurish culture, I mean culture where people produce for the love of what they're doing and not for the money. I mean the culture that your kids are producing all the time. For when you think of what Sousa romanticized in the young people together, singing the songs of the day, of the old songs, you should recognize what your kids are doing right now. Taking the songs of the day and the old songs and remixing them to make them something different. It's how they understand access to this culture.[38]

This trend in particular has raised serious questions about the value and role of professional musicians (particularly conservatory-based artistry).[39] I will also devote special attention to the pivotal role of the consumer computer in changing embodied performance practice as well as the nature of social music collaboration. My concern here is how to preserve and maintain live performance practice, cooperative social music-making, and improvisation as DMIs continuously—and swiftly—evolve.

1.2.2 Democratization of Computer Music Tools

First, let us turn towards the beginnings of using computers for artistic purposes, as the general-purpose computer has been an important democratizing agent in spawning this new amateur culture. When Newman Guttman's twenty-second composition *In a Silver Scale* was realized on an IBM 704 computer in 1957 on Max Mathews' newly created *MUSIC I* software program, it marked the birth of computer-generated music. Its significance is not due to the quality of the music, the performance capacity of the computer (at least by today's standards), or to the robustness of the software designed to perform it. It took a great deal of effort to make it happen: the computer was inadequate and the software rudimentary, though Bell Labs had

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[38] Lessig, "Laws that choke creativity," 7:53.
[39] The orchestra, a typical conservatory's most auspicious musical ensemble, is also impacted by this trend. There is a general diminishing use of many of the instruments at its core. By my observation of enrollment trends where I teach at Moorpark College, there are far more students interested in taking 'Introduction to Music Technology' than students wanting to take private lessons and enroll in the orchestra.

assembled the greatest resources available in the world at the time.[40] Nonetheless the piece marked a significant step forward in Mathews' vision of attracting composers to write music for the computer, and for musicians to be able to hear musical results in an unprecedentedly efficient way.

As an engineer, Mathews knew the learning curve was far too great for most composers to be able to work out aesthetic issues related to composing music with a computer and to learn computer programming at the same time. Mathews wanted to simplify the process to make the act of composition more efficient. In other words, he wanted to *lower the barrier of entry* for making music with computers. And the reason for using computers was that they could potentially reduce the time and effort needed to realize musical ideas. Mathews' motivations came from his frustration in being unable to reach a desired level of proficiency on the violin:

> I like the instrument very much personally, but I would call it an "inefficient" music instrument in that you have to practice more to achieve a given musical performance than with almost any other instrument.[41]
>
> …Although I've always loved to play the violin and I've had an amateur string quartet going most of my life, I was never good at it, and so I wanted to be able to make better music that didn't require such manual dexterity as almost all [musical] instruments require. I also felt that there were many composers who would compose a piece for an orchestra and who would never hear the piece, or its performance would be delayed for years, and so [the computer] would provide a way for composers to write something and hear it almost immediately.[42]

Here we see several important factors that are at the core of Mathews' motivations: 1) he was playing in a social and collaborative musical environment; 2) there was a performance practice involved; 3) Mathews recognized and appreciated music that was above his playing level; 4) the practice required to play the 'better' music he wanted to play was impractical or, in his opinion, physically unattainable; and 5) the computer offered a way to reconcile both his love of creation

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[40] John R. Pierce, "Computer Music, Coming and Going," *Computer Music Journal* 20, no. 1 (Spring, 1996): 49-51.
[41] Curtis Roads and Max Mathews, "Interview with Max Mathews," *Computer Music Journal* 4, no. 4 (Winter, 1980): 15.
[42] Tae Hong Park and Max Mathews, "An Interview with Max Mathews," *Computer Music Journal* 33, no. 3 (Fall, 2009): 10.

with the love of 'better music'. In other words, the computer provided a means for a person (in this case Mathews) to get sonic results that he could not physically produce himself (an orchestral piece or a virtuosic violin passage, for instance), but that he could *conceive of* by himself.

There are three observations I would like to make about these points that are significant to contemporary trends in music-making—particularly in relation to technology—, and each will be discussed in detail. First, Mathews' sentiment of not being able to play 'better music' but nevertheless having enthusiasm for and wanting to engage with music, is very common today.[43] Second, if taken to its extreme, Mathews' vision of bringing someone closer to realizing musical thoughts without the physical obstacles (no orchestra required to perform a composition, no virtuosic technique required to execute a difficult riff) theoretically spells an end to performance practice as it has been known, since this new way of making music significantly decreases the type of physical commitment needed to realize a performance. Third, it also ends the necessity of group performances. Thus although the physical practice and the socialized aspect of making music are not on the verge of extinction, in the years since *MUSIC I* was developed these elements have been rapidly transforming. I have begun this discussion with Max Mathews in order to illustrate that from the origin of computer music technology, issues of physical limitations and time allocation have been prohibitive factors for making 'better music.' Yet now that we can seemingly eliminate these problems through automation, automation itself has become a new problem. With *4Quarters* I propose a way for novice musicians to gain the benefits of virtuosic 'better music' being ready at hand, but to increase the level of commitment and creativity for each participant, and for the experience to be fundamentally collaborative.

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[43] Mathews likely had the classical tradition in mind when he said this, and most people today probably do not want to play 'better' music in terms of what that meant to him. Here I use 'better music' to mean music that is out of reach to a performer to execute physically.

1.2.3 'Better music' through automation

In the general consumer public the appreciation for professional musicians—or specialists, we might say—is manifested in a thriving (albeit changing) music industry, among many other indicators. This appetite for music consumption is sometimes coupled with a frustration in not being able to play music with an instrument to any satisfying degree, which might be loosely expressed in the following way: "I love great music, and since I can't do it myself, I love to hear *other* people play great music." These listeners have a sense of what great music is and would create it if they could, but since they cannot and do not have the desire or time to dedicate themselves toward that objective, they go for the next best thing, which is to hone their skills as music listening connoisseurs. This attitude conveys a different orientation toward virtuosity than in past generations, where the virtuoso was seen as a beacon worthy of emulation, motivating amateur players to dedicate time toward improving skills through increased practice with a given instrument. In this contemporary consumer-centric view, virtuosity is something that specialists attain that most likely has nothing to do with the listener's daily life beyond the mediatized listening experience.

This attitude is understandable. Dating back to the earliest gramophones and phonographs, the allure of automated playback has been at the core of the consumer-based recording industry.[44] The tedium of training on an instrument and its corresponding limits on song selection and realization could be replaced by a wide selection of recordings by world-class performers. Thus this disruptive technology initially curtailed performance practice, replacing it with automation.

Today many devices and video games offer essentially the same basic musical controls that require minimal commitment from a performance standpoint while automating very sophisticated computational processes and permitting musical results far exceeding the user's

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[44] Emily Thompson, "Machines, Music, and the Quest for Fidelity: Marketing the Edison Phonograph in America, 1877-1925," *The Musical Quarterly* 70, no. 1 (1995): 131-171.

abilities. Using the iTunes application, for instance, customized playlists permit one to express creativity in the careful selection and ordered sequence from thousands of songs in an iTunes library.[45] Streaming services such as Pandora algorithmically filter music content based on the user's initial search criteria. An obvious but perhaps overlooked form of control in music playing is the ability to tune in or tune out anytime and anywhere, with only perhaps battery power, internet connectivity, or radio reception being limiting factors.

Perhaps because the general public's relationship with recording technology has historically reinforced the concept of recording as *facsimile* of a performance (rather than recording as resource for creative expression), for most people the concept of turning up the volume knob or pushing the play button cannot be considered performance, even in the loosest definition of the term. One presses the play button to listen to virtuosity through a mediated format; however the choice of listening to Andrés Segovia vs. Joe Satriani (for example) is not a compositional or performance decision but a matter of taste. It is not an act of intellectual craftsmanship (which an exquisite composition or superlative performance might exemplify), but simply a mundane or banal choice more akin to turning on, off, or dimming a light switch, possibly made while doing something else.[46] In contemporary electroacoustic circles, however, pressing the play button need not be viewed as a completely separate activity in opposition to virtuosic musical performance; these two types of music-making might be two poles at opposite

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[45] Apple, Inc., "Apple – iTunes – Everything you need to be entertained," 2013, accessed February 28, 2013, http://www.apple.com/itunes/.

[46] I deliberately exaggerate here to highlight classical/romantic notions of the virtuoso as described in Hunter (2005) and Pincherle and Wager (1949). To summarize briefly, the virtuoso is largely an instrumentalist and interpreter, and his/her role works in concert with the composer (if the performer is not the composer) to convey brilliant thoughts. This model foregrounds the composer as genius by charging the virtuosic performer to become a vessel to transmit the thoughts of the composer to the audience without 'getting in the way,' so to speak. For an amusing commentary on the twilight of the age of virtuosity as a means of showcasing extreme dexterity and superlative skill at the expense of other ideals, see Burk (1918). I also deliberately choose Segovia and Satriani as two examples of virtuosi whose performance and interpretive skills reinforce these models. Mary Hunter, "'To Play as if from the Soul of the Composer': The Idea of the Performer in Early Romantic Aesthetics," *Journal of the American Musicological Society* 58, no. 2 (2005): 357-398; Marc Pincherle and Willis Wager, "Virtuosity," *The Musical Quarterly* 35, no. 2 (1949): 226-243.

ends of a *continuum* of possible forms of musical performance. They are viewed as relative rather than absolute. In a letter exchange published in the autumn 1992 issue of *Computer Music Journal*—the subject being 'active' digital musical instruments and their ramifications—Laurie Spiegel suggested such a continuum as being one of several axes in a multi-dimensional representation of interactive music generation.[47] For the purposes of the present discussion I quote only two of sixteen suggested axes of continua, though other parameters Spiegel lists are relevant to later chapters:

> Axes of such multi-dimensional representation of interactive musical generation might include such continua as the following: degree of human participation (completely passive listening versus total creative responsibility); amount of physical coordination, practice, and/or prior musical knowledge required for human interaction...[48]

The point Spiegel makes is that computers and controllers have permitted new levels of interaction and types of engagement, where the programmer can dictate the degree of effort and commitment required by the performer, and the physical coordination necessary to engage with the 'active' instrument may not be demanding at all. This obviously disrupts traditional definitions of composer and performer, and their corresponding roles, and has significant ramifications not only for who does what, but for musical outcomes and the values represented by those outcomes. I only mention this briefly here, as it is the topic for section 2.2 – *Blurring roles: composer, performer, and audience*; but being able to view these roles as fluid is central to my compositional interests, my desire for non-musicians to feel empowered to make music and compose creatively, and the design of *4Quarters*. In later sections of this chapter, I will discuss several examples that can be plotted along various points within Spiegel's continua, examples that have influenced key design decisions in the *4Quarters* architecture. As it was for Max Mathews, the appeal of bypassing certain physical limitations in music-making is attractive to me; but this need not dispense with *practica musica* altogether. By design in *4Quarters* it is

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[47] Neil Rolnick and Laurie Spiegel, "Performing with Active Instruments," *Computer Music Journal* 16, no. 3 (1992): 5-6.
[48] Ibid., 6.

possible to bring those who feel like they cannot play 'better music' a little further beyond passive listening toward increased creative ownership in the music generation process. In *4Quarters* a performer, who may be a self-described 'non-musician,' can push a button to trigger a sound file with musical content that is far more virtuosic and nuanced than he/she might be able to perform otherwise. [This is similar to typing on a computer or driving a car: one can wield these tools without having an extensive knowledge on how the tools work under the hood.] Generally the act of rapid file selection has not been thought of as performance, but *4Quarters* makes use of it as a performance technique. This is similar to DJ performance practice, where music is chosen and mixed on the fly.

1.2.4 Performance practice and computer prowess

Today digital audio workstations (DAWs) and notation editors such as *Garageband* and *Finale* are the tools that come the closest to meeting Max Mathews' vision, and they are widely available.[49] Though surely Mathews did not intend for the computer to eliminate performance practice or the collaborative social aspect of making music, there is a whole generation of people who have the ability to make music with their computers (usually in isolation), hear the results, and proliferate it digitally with no need to develop the manual dexterity required to execute difficult passages. Perhaps even more significant, one does not need to be able to read traditional music notation. "The advent of the computer and electronics in music has created a host of tools for the composer to use which are geared not toward the representational, visual aspect, but toward sound itself."[50] Creative impetus is not tied to a physical visceral exercise requiring discipline and carefully timed execution of movement, but is instead tied to cerebral

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[49] Apple Inc., *Garageband '11*, 2013, accessed February 28, 2013, http://www.apple.com/ilife/garageband/; MakeMusic, Inc., *Finale*, 2013, accessed February 28, 2013, http://www.finalemusic.com/.

[50] Gordon Zaft, "Computers as Tool and Technique," 1996, accessed May 8, 2012, http://www.zaft.org/gordon/mse596s/music.html.

exercises of repeated listening, tweaking, and 'futzing' through a myriad of edits.[51] Performance practice in the traditional sense is replaced by computer acumen.

In a keynote address at the 2001 ICMC, Cycling 74 President David Zicarelli asserted, "the musical process with [computer] technology is of a piece with word processing. I feel no qualitative difference in the computer skills I need in preparing this text, revising words here and there, than I do preparing a piece of music."[52] This comparison is significant because it indicates that for the millions of people who use computers to do word processing and other office-like tasks, the shift to use those skills in a musical fashion is not a tremendous or intimidating commitment the way that learning and mastering an instrument is.[53]

This shift is, in my opinion, both an advantage and a disadvantage. For those who do not have a background in conservatory-based instrumental training, and especially for those who are not likely to put in the time anyway, the computer serves as a gateway to allow people to write, create, and have a connection with music that otherwise might not have occurred. The familiarity with copying, cutting, pasting, and navigating a graphical interface with menus, buttons, and sliders allows non-musicians to feel empowered to make music. It is precisely this reason that I choose to focus on mobile phones as controllers rather than some other device. The computer is a gateway to musicianship, as is the phone.

At the same time, is there a collective cultural loss in decreasing support of traditional performance practice—even if inadvertently—by throwing more technology toward plug-ins,

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[51] Admittedly, computer editing does typically involve physical movements on a minute scale: moving the mouse and navigating the QWERTY keyboard requires its own type of dexterity. That said, since the sequencer ultimately executes the music in time, the physical movements of the embodied user are not exacting in the same way that playing a musical instrument might be, since the time scale in which these movements take place is radically different for each respective musician.

[52] David Zicarelli, "ICMC 2001 Keynote Speech," 2001, accessed August 2, 2011, http://finearts.uvic.ca/icmc2001/after/keynote.php3.

[53] The comparison also might explain at least partially why the Introduction to Music Technology class I teach at Moorpark College is always filled to capacity the first day of each semester, the majority having no background in playing musical instruments or reading traditional music notation.

samples, easy-to-use software tools, and increased automation? As 'high art' diminishes in cultural relevance, which upholds the notion of the composer as specialist, etc., and as we move toward music that is driven by popular social trends, what is to be gained? Paul Lansky speaks ominously about what is at stake:

> To my mind there is no correlation between automation and musical virtue. The music doesn't get better simply because one person can do the work of fifty in a fraction of the time. It probably gets worse. There is also no virtue in the fact that we have come to accept the sound of machine-made music as reality in our media. As a matter of fact, I think we will pay a very stiff price in the loss of generations of people who can make wonderful sounds with their mouths, fingers, and toes.[54]

To a certain extent, we might say that Lansky was a little hasty to sound the warning bell (alternatively, we might say that Lansky's vantage point hastened the movement): since 1990 there has been a tremendous amount of interest in making computer music a more physical and visceral experience. A growing community of scholars has been devoted to topics such as gestural control [Kurtenbach and Hulteen (1990), Henrotte (1992), Iazzetta (2000), Chabot (1990), McNeill (1992)], live embodied performance [Leppert (1993), Emmerson (1994), Jaffe and Schloss (1994), Rovan et al. (1997), Neill (2002), Ostertag (2002)], and human-computer-interface (HCI) design [Laurel (1990), Mulder (1996), Wanderley and Orio (2002) are some examples, as well as the flourishing corpus of research and works for *New Interfaces for Musical Expression (NIME)* conferences, initiated in 2001].[55] As DMIs evolve, become cheaper, and can accommodate a greater variety of physical input, automation becomes less of a threat to replace performance, but instead becomes one of several factors in instrument design that influences performance practice (this hearkens back to Spiegel's axes). So if we are to look at the development of music-making with computers, it might be worthwhile to view the threat of losing a physical performance practice as a bump in the road of a much larger timeline of instrument development. If we assume a position of being in the infant stages of a new era of

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[54] Paul Lansky, "A View from the Bus: When Machines Make Music," *Perspectives of New Music* 28, no. 2 (1990): 105.

[55] Citations for these works are located in appendix A at the end of the dissertation.

instrument design, then it is quite possible that future generations may be making 'wonderful sounds with their mouths, fingers, and toes,' and possibly their eyebrows too.[56] In other words, we cannot know yet whether the computer as musical instrument will extinguish amateur performance practice simply because it is impossible to know what types of performance practices will emerge with new interfaces. Neil Rolnick observed that the rapid changes in technology as it pertains to DMI design make assessment even more difficult:

> Such interfaces and performance systems, to date, have generally required that the performer be at least as conversant with computers and programming as with music. Furthermore, since these interfaces are at least in part computer peripherals, they tend to mature and change at the tempo of the computer industry, rather than at the tempo of the musical instrument industry. This means that the actual devices themselves (e.g. *VideoHarp, Air Drums, Hands, Thunder,* and *Lightning*), are likely to be replaced or radically transformed at least every two or three years.[57]

In the previous section I proposed a 'benchmark' for an instrument's development, being that it can accommodate virtuosic performance. Rolnick suggests that, particularly as peripherals and computational power are evolving so rapidly, we might want to withhold assessing instruments based on their ability to engender and sustain performance practice until an accompanying musical literature can be developed, and fluency in exploiting the instrument's capabilities can emerge. Rolnick puts it this way:

> If we had rearranged the keys on the piano every few years, it's unlikely that we would have ever progressed from the virtuosity of Mozart to the much more idiomatic virtuosity of Chopin or Liszt. It is a matter of generations learning a musical literature that builds both musical and technical fluency—and it has to take time.[58]

1.2.5 Music performance as social activity – the loss of the servant performer

The significant downside to being able to 'do the work of fifty in half the time' with a DAW, as Lansky describes, is that the person making the music is doing so in isolation, at least in the

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[56] See Daito Manabe's attempt to copy his facial gestures onto his friends', and to have these correspond to sounds. Daito, "Copy my face to my friend's –test 0 (unsuccessful…)," November 5, 2008, video clip, accessed February 28, 2013, Youtube, http://youtu.be/VtRVvBSbonk.
[57] Rolnick and Spiegel, "Performing with Active Instruments," 5.
[58] Ibid.

'creation' phase. For example, unlike Max Mathews, it is safe to say that today most people who benefit from his contributions to digital music do not regularly play in an amateur string quartet, or in any amateur ensemble. The social aspect of music-making still happens, but for the consumer public it predominantly takes place in the form of *sharing* music: either listening together in social situations or recommending music for someone else to hear at another time, in another place.[59] Instead of getting together with friends to practice, the prototypical hobbyist laptop musician works alone on a computer until satisfied with a complete track, and then posts that track on Facebook, YouTube, or SoundCloud for others to hear.

In Smule's *Ocarina* iPhone app, this form of audience displacement by location and time is deliberately leveraged. By design the app makes it easy for a user to capture and post a recording of the instrument online, and for a user to be able to hear snippets of audio of other *Ocarina* users from around the world using the *World Listener* view within the app environment. According to Wang, "over 20 million snippets have been created and shared, each with precise timing, key, melody information."[60] Wang continues "the anonymity of the social interaction is also worthy of note – everyone is only identified via a self-chosen handle (e.g., Link42), their GPS location, and through his/her music. And yet, according to overwhelming user feedback, this seems to be compelling in and of itself." In other words, the attraction is the ability for someone to feel connected—albeit in a superficial way—to other people across the globe, playing the same instrument and sharing music, but without name, nationality, or other significant contextual features. This is truly a new format of communal musical sharing, but does the sense of connecting with people in far away places justify displacing highly localized communities such as the amateur string quartet? Is there a meaningful social connection in the sharing of recordings even if it is impossible to know the audience in a networked repository such as this?

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[59] Lansky, "A View from the Bus," 107.
[60] Wang "Designing Smule's iPhone Ocarina," 306.

Before these things came to be, Max Mathews was trying to create an alternative tool to allow the composer to self edit the orchestra piece before it got to the rehearsal, but not to wipe out the rehearsal and premier altogether. He certainly did not aim to curtail the process of working socially to get musical results. Yet as public habits with consumer music applications and devices have developed, this is essentially what has occurred. Lansky remarks that with the advent of affordable DAWs the increased reliance on automation "has created a healthy swelling in the ranks of performing composers and composing performers and shrinkage among the ranks of servant performers."[61] He then parenthetically adds,

> This latter fact is deeply disturbing. In the near future, if not already, the ability of a violinist to make a living in commercial areas will virtually disappear. It remains to be seen whether this predicts a decline in performance study, but it is troublesome.

What we do know is that 'democratized' music technologies that bring immediate aural feedback to the composer do not necessarily bring a corresponding knowledge about how to make music with *human* ensembles when they are sought out.[62] Anyone using a notation preparation software tool like Finale or Sibelius can write for a flute to play well below middle C, but a lack of knowledge about tessituras and instrumental ranges can create frustrations for the 'servant performer' if such a performance is imminent. This is a common problem among budding novice musicians and less an issue for seasoned composers, but for the International Federation of Choral Music (ICFM) the phenomenon has been problematic enough to prompt the jury committee for the 2012 International Competition for Choral Composition to address the issue directly in their call for works. In the first competition in 2011 the jury frequently found "the deep-seated flaws in many a piece submitted, choral 'essays' that evinced either a total lack of understanding or any first-hand experience of tessitura and vocal range, inhabited a

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[61] Lansky, "A View from the Bus," 104.
[62] Here I refer to software tools that allow lay musicians to gain easier access to making music than developing proficiency on an acoustic instrument. This context assumes that a user has a working understanding of computer software but does not necessarily play a musical instrument.

mawkish sound-world, demonstrated an inability to score effectively, proffered some quite maladroit voice-leading, and – surprisingly often – a plethora of harmonic 'infidelities' within an avowedly tonal but weak musical structure."[63] Subsequently, the new guidelines included a solicitation for composers to conscientiously avoid software notation tools in favor of an older technology—pencil and paper:

> An overreliance on notation programs, coupled with the ability to input music directly at a computer interface, has, we fear, weaned budding composers away from a simple sheet of paper and a HB pencil. Pressing such an implement into the page is an entirely different haptic experience and will result in radically different music. We have nothing against Finale or Sibelius or Score, they are all amazing tools of the trade, but this is what they remain…something to be used after the fact, as soon as a piece has been composed.[64]

In this context it is noteworthy that the influx in underprepared music indicates a healthy enthusiasm for new composers seeking performance opportunities, and they are submitting scores regardless of whether they have the first-hand experience with choirs. Based on the nature of the solicitation—designed to raise the level of musicianship and address this particular audience—there is a clear admission of the connection between technology as a gateway tool and this new demographic of submitters. This is neither a good nor bad; it is more indicative of changes in who is making the music and how it is made. Of interest here is that technology is simultaneously democratizing and isolating—more people are gaining access to tools for musical creation, but that access reflects the loss of the social experiences that up until recently were part and parcel with the training required to produce musical scores.[65]

The lack of musical community involvement in making music becomes far more acute in the realm of personal portable players like the iPod. Consider the following mission statement

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[63] Graham Lack, "Composition Competition 2012," *International Choral Bulletin*, accessed October 27, 2012, http://icb.ifcm.net/?page_id=314.
[64] Ibid.
[65] As an aside, whereas private instructors and educators may have traditionally filled the role of mentoring and guidance for submissions such as the ICFM competition, here a jury committee adapts to include an addendum to fill in the gaps in orchestration instruction that have traditionally been filled through formal education.

from the homepage of Project SAME (Sound And Music for Everyone Everyday Everywhere Everyway), an initiative by IRCAM, Nokia Research Center, and several EU universities that transpired from 2008-2010 and focused on transforming mobile devices from tools for passive music consumption into tools for active music-making:

> Music-making and listening are a clear example of a human activity that is above all interactive and social, two big challenges for the new communication devices and applications. However, to date music-making and listening is usually a passive, non-interactive and non-context sensitive experience. The current electronic technologies, with all their potential for interactivity and communication, have not yet been able to support and promote this essential aspect of music-making and listening. This can be considered a significant degradation of the traditional listening and music-making experience, in which the public was (and still is) able to interact in many ways with performers to modify the expressive features of a music piece.[66]

To a certain extent, this attitude and project maps onto a whole movement toward interactive apps that has become feasible because of 'the tempo of the computer industry,' with handheld devices having increased computational power, storage capacity, more sophisticated sensors, and a strong commercial ecosystem for app developers and consumers. It is possible that it is simply the right time to move toward regaining live performance, and in many respects phones do a better job of being used as instruments than laptops. Regardless, the mission statement indicates that with the iPod something is missing, whether it is the loss of the performer, a sense of community, or a loss of effort required to give life to the music. Though technologies do not inherently yield certain predetermined practices or outcomes, there is a clear sense that either design needs to improve to steer users in the right direction to regain values that are drifting away, or—harkening back to the IFCM petition for submitters to use pencil and paper—we as users need to choose to keep our relationship with music technology in proper perspective.

1.2.6 Games as performance tools

If the DAW on a laptop is the *compositional* tool of the common hobbyist musician, then video games—particularly popular games *Guitar Hero* and *Rock Band*—fall into the realm of

[66] SAME Project, accessed May 11, 2009, http://www.sameproject.eu/.

performance tools of the common hobbyist musician.[67] The DAW foregrounds recording, editing, playing back and tweaking – an activity of music-making that does not occur from start to finish in 'real time'. (On a personal level this is very close to the most common way I approach composition, with spurts of improvisation followed by consternation, revising, and moving notes around). In contrast, music-centric video games are more closely associated with traditional performance, typically providing activities such as score following, playing in tempo, and coordinating complicated maneuvers in real-time. Kiri Miller (2009) adroitly addresses the concept behind playing these games:

> Descriptions of *Guitar Hero* gameplay often reduce the basic game activity to "pushing buttons in time." This summation is not inaccurate, strictly speaking, but it fails to capture the feeling and the appeal of gameplay for most players—much as it would fail to capture the feeling of playing a Chopin nocturne at the piano, which might also reasonably be described in these terms. If one sets aside all of the rock-related framing devices—the instrument controllers, the on-screen avatars, the repertoire—the core challenge-and-reward system in these games is a sight-reading emulator.[68]

According to *Guitar Hero* and *Rock Band* co-creator Eran Egozy, the purpose of these games was to merge technology and music in such a way for it to "be useful for everyday people, not just expert musicians."[69] He continues, "This great feeling you have when you're playing music – very few people get to experience that. And what we've done with games like *Rock Band* and *Guitar Hero* is try to grab some of those feelings, some of those hard-to-describe connections that you get with people because of music." Here Egozy highlights two issues that are central to

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[67] An excellent example of online democratized amateurism can be found at http://www.squidoo.com, a user-generated website devoted to people sharing what they love. Howard Yermish wrote a 'lens'—the site's term for a narrative on a given topic—on computer music, and caters to hobbyists with his 'how to' page for interested computer music beginners. Yermish writes, "Computers have completely changed the landscape of not only what kind of music composers create, how we create it, and even more interestingly, who considers themselves a composer. More people are trying their hands at writing music in some form or another. Computers are empowering more people to compose. This lens is dedicated to helping more people engage with music composition." Yermish, "Creating Music with Computers," *Squidoo*, accessed July 2, 2012, http://www.squidoo.com/computermusic.

[68] Miller, "Schizophonic Performance," 408.

[69] Eran Egozy, in "Secret Life of Scientists: Eran Egozy: Game Developer," *PBS Video*, posted October 28, 2009, video clip, accessed July 2, 2012, http://video.pbs.org/video/1303047306/.

the discussion of democratized music-making with DMIs: first, he draws attention to how few people *consider* themselves to be musicians, and tries to bring the musical creative experience to the masses. This brings us right back to the appeal of virtuosity, the fascination with musical expression, and the seeming divide separating trained musicians from everyone else—"*I love great music, and since I can't do it myself, I love to hear other people play great music.*" Second, Egozy addresses one of the chief concerns about certain music technologies (e.g. DAWs, iPods) tending to induce isolation; although these games can be played alone, multiplayer use is the default premise.

In Section 1.1 I discussed Ruviaro's assertion that instrument designers must define what an instrument does and make its functionality discernable to both the performer and audience, and that accomplishing that 'sweet spot' is not easy. Egozy and Rigopulos's failures leading up to their breakout are widely chronicled, but they were eventually able to create a product that gave non-musicians immediate access to musical performance while also providing an environment to allow users to progress within the game framework.[70] Tod Machover, who mentored Egozy and co-creator Alex Rigopulos while at MIT, does not see these video game experiences as replacements for learning instruments, but perhaps as a gateway: "Most of the activities I'm involved with are getting people to the core of musical expression as fast as possible and then setting up an environment where they enjoy it enough to spend days or years getting better at it."[71] These two points of focus—accessibility coupled with sustainability—may serve as a template for future success as DMIs continue to develop.

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[70] Maggie Overfelt, "How 'horrendous failure' led to Rock Band," *CNN Money*, accessed July 2, 2012, http://money.cnn.com/2009/09/03/smallbusiness/harmonix_rock_band_startup_story/index.htm.

[71] Tod Machover, in Erica R. Hendry, "Tod Machover on Composing Music by Computer," *Smithsonian Magazine,* July-August 2010, accessed July 2, 2012, http://www.smithsonianmag.com/specialsections/40th-anniversary/Tod-Machover-on-Composing-Music-by-Computer.html.

From a revenue standpoint, *Rock Band* and *Guitar Hero* in particular have been wildly successful, spawning other iterations—*DJ Hero*, *Band Hero*, plus *Rock Band* versions for specific bands—and forming the backbone of the instrument-based rhythm game sub-genre. In spite of declines in sales after 2009, the *Guitar Hero* franchise topping The NDP Group's list of all-time best selling video games in 2011.[72] We might reasonably say that, with the exception of perhaps the keyboard synthesizer, these games represent the most successful and farthest-reaching DMIs to date. Of interest here is that this success might suggest useful 'ingredients' for fostering accessible and sustainable performance formats.

As the games are performance-oriented, the concepts of musical virtuosity are implemented in two main ways: first, the element of practice and dedication required for mastery (a common element in musical performance *and* videogame ontologies); and second, the theatrical aspect of performance: showmanship, spectacularized physical performance, or as designer Rob Kay describes it, "star power."[73] Miller observes the formation of two broad camps of *Guitar Hero* players that map onto these two facets of virtuosity, which she calls 'score-oriented' and 'rock oriented.'

> Members of both groups are generally *performance*-oriented, but they employ different performance-evaluation criteria… The score-oriented treat these games as well-defined rule-bound systems, in which the main challenge and satisfaction lies in how to exploit the scoring mechanism to best advantage… Rock-oriented players realize that rock authenticity is performative. They generally do value their videogame high scores, but they also believe creative performance is its own reward. As they play these games, they explore the implications of their role as live performers of prerecorded songs.[74]

Some players go so far as to do extreme parodies of glam-rock bands of the 1970s, demonstrating a kind of self-aware *virtual* virtuosity.[75]

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[72] Chris Morris, "Call of Duty, Guitar Hero Top All-Time Best Selling List," last modified March 24, 2011, accessed July 2, 2012, http://www.cnbc.com/id/42253109.
[73] Miller, "Schizophonic Performance," 412.
[74] Ibid., 418.
[75] freddiew, "Guitar Hero 2 Rush YYZ on Expert," October 28, 2006, video clip, accessed June 1, 2011, Youtube, http://www.youtube.com/watch?v=Ua3hZXfNZOE.

These types of spirited meta-performances are deeply steeped in rock archetypes and metaphors and are not necessarily useful templates for musical scenarios outside this genre, but to me they illustrate two significant points: first, in spite of the formation of new types of virtuosity (high scoring video game players as well as showboating players), these games do not disrupt the currency of the traditional instrumentalist. If anything, because many feel that the *Guitar Hero* controller is a 'fake' version of a 'real' guitar, these virtual displays of performance are frequently compared to their 'analog' predecessors. Second, both *Guitar Hero* and *Rock Band* were not designed to be a musically creative experience, yet the existence of the rock-oriented group indicates the potential and desire that many players have to be able to insert creativity above and beyond the limits of the game.[76] This is especially meaningful in my design of *4Quarters*, which similarly presents prerecorded sound files that are made available for performers, but doesn't couch the experience in a score-following format. Neither these video games nor DAWs lend themselves to improvisation very well. This might be a third area of virtuosity that might be explored down the road.

1.3 Collage, Quotation, and Authorship

1.3.1 Introduction

With the penetration of mobile phones as tools and interfaces for composition, performance, and musical reception, there has been a recent focus on so-called 'interactive' music apps.[77] In the realm of music apps for the mobile phone, this term is usually meant to

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[76] When asked by Miller to what extent *Guitar Hero* was a creative musical experience, designer Rob Kay replied, "Very low… From the very beginning, we didn't ever think that Guitar Hero was creative in its direct application… The real kind of creative space of actually deciding to do your own thing isn't really there in Guitar Hero." Miller, "Schizophonic Performance," 417.

[77] The buzzword 'interactivity' is used fairly indiscriminately to describe a wide range of computer-based activities, and in many cases the interaction is unremarkable. Furthermore, interactivity is not something that spawned from the computer chip nor is it endemic to mobile apps—after all, is a digital musical instrument any more interactive than playing the bassoon? (McIver Lopes, 67) In spite of its triteness, 'interactivity' still can be meaningfully descriptive when viewed in the context of mobile devices that preceded smart phones. When comparing the

distinguish the 'interactive' musical experience—where the aural results are shaped by user input—from simple audio playback. The change in the role of the user from audience to performer/composer is subtle, but it has significant ramifications in terms of authorship. The well-established roles of composer, performer, and audience in the concert-oriented tradition are dissolved into a collaborative and derivative musical process where the resulting remix is often disposable. In contrast to the romantic orientation of authorship, where the artist is viewed as a genius and elevated, autonomous individual, a different aesthetic and value economy is emerging in digital arts and particularly with mobile music, where every person—regardless of aptitude—can be the artist. My argument is that the technology is the primary facilitator of this change. In order to gain context for this shift, I will first examine romantic aesthetics of authorship in terms of intention, ownership, and originality to illustrate how these values are diffused and refashioned in mobile music. Of the ever-growing number of mobile apps available, I will limit the discussion to *ZooZBeat*, *MadPad*, *RjDj*, and *4Quarters*, each of which emphasizes remixing, collage, and quotation techniques in its design.[78] Though any discussion of music and remixing makes for an easy segue to digital copyright laws and ownership disputes, these topics will only be explored to the extent that they inform what is meant by authorship. My intent is to demonstrate that, of the many modes of sampling practice, mobile music in particular is not only democratizing (and in certain cases trivializing)

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fairly straightforward activities—primarily simple playback—permitted by previous mobile devices such as the Walkman, iPod, or other playback devices, many mobile music apps offer a significantly different experience, leveraging user input through touch, microphones, accelerometer data, and in some cases GPS to shape musical results. In contrast to the Walkman/iPod format, where the user is clearly functioning as a recipient of other artist's work, the focus of many of these new apps is to empower the user to make musical decisions and in some cases compose music of his/her own. Dominic M. McIver Lopes, "The Ontology of Interactive Art," *Journal of Aesthetic Education* 35, no. 4 (2001), 65-81.

[78] *ZOOZbeat*, accessed October 27, 2012, http://www.gtcmt.gatech.edu/research-projects/zoozbeat; "MadPad: Remix Your Life," *Smule*, accessed October 27, 2012, http://www.smule.com/madpad; "Sonic Experiences of the 21st Century! – RjDj," *Reality Jockey Ltd.*, 2012, accessed October 27, 2012, http://rjdj.me; Nathan Bowen, "4Quarters: Real-Time Collaborative Music Environment for Mobile Phones," in *Proceedings of the 1st Symposium on Laptop Ensembles and Orchestras (SLEO)*, Baton Rouge, USA, 2012, 83-87.

composition, but also rapidly dismantling romantic and modernist ideas of individuality in the process.[79]

1.3.2 The Impact of Technology on Authorship

In considering the changes in aesthetics and values that have defined notions of authorship since the romantic period, technology frequently plays a crucial role. It helps define who has the power, the format of transmission of ideas, and the roles of the participants involved. For instance, one might reasonably find a connection between the concept of individual-as-genius and the media of transmission. In literature, the image of the heroic 'man of letters' was in part enabled by the printing press and the ability to broadcast one message to many consumers of that message. Because of the power of that method of transmission, and because the expense of the tools for reproduction were relatively high, this meant that a premium had to be placed on whose words were worth putting into print. Hence professionals handled the work, both the selection of what got printed and the content creators. The well-defined professional class then crystallized the image of the author as genius. In the concert music tradition, this same situation applies: an individual composer's work is broadcasted to an audience through performers. Selection of the individual(s) whose work is performed is controlled and filtered by concert programmers and patrons, or depending on the organization, by the owners and operators of the physical concert space. The direction of communication is

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[79] The bulk of current research on the topic of musical authorship is not focused on mobile technologies in particular, but is situated in older forms of sampling technologies, particularly analog sampling tools and digital audio workstations. To a certain extent the apps that are available for mobile devices are merely extensions of those tools, offered in a more convenient albeit limiting form. That said, because the apps offer a more streamlined approach to both obtaining sampling materials and proliferating remixes, and because many of these apps offer a packaged 'readymade' approach to a specific type of engagement, and because there are so many apps and 'scenes' and 'sets' within apps to choose from, I maintain that the mobile tools are closer to Duchamp's aesthetics of dissociating the work of the artist (or programmer) from the value of the resulting artifact. The emphasis shifts from 'work of art' as valued commodity, intended for musical reception and appreciation, to 'making music' as the valued activity, intended for private exploration and manipulation, and eventual sharing with close friends. Selection becomes the defining characteristic of the identity of the user.

relatively fixed, like unto a one-way street: the audience does not communicate back to the composer in a dialogue. It is akin to a rhetorical sermon where one speaks and many listen. Recording technologies, film, and photographs all have the same effect, allowing the message of an individual to be disseminated to many via replicable physical objects. Radio and television are also technologies that reinforce the one-to-many format of communication, but on a massive scale. Generally speaking, all of these technologies have been expensive, in the hands of few, and were initially controlled by professionals.

Telegraph and telephone communication brought about a significant change because they permit *two-way* conversations, but as Clay Shirky points out, these media primarily work best with one-to-one communications. Speaking about the technological revolutions that preceded the internet, Shirky said,

> …There is a curious asymmetry here. The media that is good at creating conversations is no good at creating groups. And the media that's good at creating groups is no good at creating conversations. If you want to have a conversation in this world, you have it with one other person. If you want to address a group, you get the same message and you give it to everybody in the group, whether you're doing that with a broadcasting tower or a printing press. That was the media landscape as we had it in the twentieth century.[80]

According to Shirky, the internet changed all this. "The Internet is the first medium in history that has native support for groups and conversations at the same time. Whereas phones gave us the one-to-one pattern, and television, radio, magazines, books gave us the one-to-many pattern, the Internet gives us the many-to-many pattern."[81] Perhaps more importantly, members of the former audience can now also be producers and not consumers. "Every time a new consumer joins this media landscape a new producer joins as well, because the same

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[80] Clay Shirky, "Clay Shirky: How social media can make history," filmed June 2009, TEDvideo, 15:48, posted June 2009, accessed October 27, 2012, http://www.ted.com/talks/clay_shirky_how_cellphones_twitter_facebook_can_make_history.html#192000.
[81] Ibid.

equipment—phones, computers—let you consume and produce. It's as if, when you bought a book, they threw in the printing press for free."[82]

This is the context in which mobile music apps are emerging, and I will focus in particular on apps that leverage this unique feature of natively permitting both consumption and production. In the case of mobile apps *ZooZBeat*, *MadPad*, *RjDj*, and as is also the case with *4Quarters*, there is a strong connection between consumption of musical content and the creative appropriation of that content. As all of these apps are designed to empower novice musicians, the nature of authorship changes to support the notion that "everybody is the artist". The success of these apps is made possible by taking advantage of some basic characteristics of mobile devices: they are ubiquitous, potentially always networked, and always with the user.[83]

1.3.3 Authorship and Mobile Apps

The mobile app *ZooZBeat* is a gesture-based mobile music studio designed to provide immediate engagement and self-expression for novice players, while at the same time creating a space for seasoned musicians to practice, improve, and perform at a high skill level.[84] The format of the music-making environment is akin to digital audio workstation software usually associated with a personal computer (e.g. *Garageband*, *Logic*, *Cakewalk*, etc.). *ZooZBeat* is furnished with instrument tracks, background loops, a beat grid, and predetermined scales. There are seven instrument tracks available for recording: three percussive tracks, three melodic tracks, and one 'microphone' track where audio input from the phone's onboard microphone can be captured. When launching the app one can choose from a variety of templates of instruments and background loops that are associated with different genres (e.g. 'Hip-Hop', 'Rock', 'Salsa', etc.). As is the case with many mobile music apps, some predetermined features

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[82] Ibid.
[83] Barry Brown, "Studying the Use of Mobile Technology," in *Wireless World: social and international aspects of the mobile age*, eds. Barry Brown and Nicola Green (New York: Springer-Verlag, 2002), 5.
[84] Weinberg et al., "ZooZBeat," 312–315.

provide a structure for novices to be able to make performance mistakes without risk of the musical outcome sounding 'bad'. For instance, a user may be able to improvise over a steady background loop with a handful of diatonic harmonies, but the melodic pitch content will be limited to a pentatonic scale so that no dissonance can be created. There is an obvious tradeoff at work here: by restricting the range of musical choices and possible outcomes, the app design favors immediacy of creation over artistic uniqueness. By limiting harmonic and melodic options while imposing a looping beat grid that quantizes a user's rhythmic input, the app design restricts the expressive range and the variety of music that can be produced in favor of allowing a novice musician to feel creative.

ZooZBeat designers also had to make decisions about how to create an intuitive physical sensorial experience that would make sense for people with drastically different performance backgrounds.

> For musicians, a set of complex muscle memory mappings defines the sensation of playing music... For the non-musician, musical gestures are based more on the experience of watching musicians play rather than their own muscle memory. Our main design goal therefore was to find intuitive mappings between gestures and a loop-based music sequencer, ones that users, both musicians and non-musicians, can immediately recognize and interact with.[85]

User input can be captured via tapping the screen to enter notes, shaking the phone like one would strike a drum (this is most effective and intuitive when recording on a percussion-based track), and tilting the phone in various angles to control pitch and rhythmic content. Additionally, there are two special angles when using tilt designed to create a heightened level of musical activity, meant to be associated with dramatized gestures that many classical performers make by tilting their instruments.[86] If one tilts the phone up, the sequenced notes are subdivided into two, and if tilted down, the sequenced notes are subdivided into three.

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[85] Ibid., 312.
[86] Ibid., 312.

To create a full-fledged song, one can compose multiple 'sections,' each of which are loopable and can be stored and then performed altogether in sequence. The song can then be shared online, as a ZooZ Radio feature within the app links the user to the ZooZ community. On the startup screen there is also a feature to 'Get New Beats'.[87] These beats are provided by the makers of the app, rather than by a community of composers. Still, ZooZBeat was designed with group-play in mind: several devices can be linked together to play 'hot potato with sounds.[88]

MadPad, developed in 2010 by Stanford University CCRMA student Nick Kruge and then published through Smule in 2011, is a video sampling app that captures video and sound into a touch-based twelve-button layout.[89] Drawing inspiration from consumer electronics devices such as Akai's Music Production Center (MPC), the basic function of this app is to record audio and video in small snippets, but then to format these snippets in such a way that they are immediately playable in any order.[90] At its core the app is a tool for collage: the portability of the device coupled with the onboard camera and microphone make it easy for anyone to capture everyday 'found' sounds, and then to use them musically. The app slogan "Remix your life" underscores the idea of sonic exploration within everyday activities. For instance, one default set of sounds included in the app entitled "1991 Honda Accord" features a person hitting various parts of a car, while the set "Soda POP!" is comprised of twelve different sounds of a person striking, tapping, and tugging at a soda pop can.

Similar to *ZooZBeat*, the app is designed to facilitate music-making as fast as possible. On launching the startup screen, one can start his/her own remix by using a default 'set' of twelve video/audio samples, browse through hundreds of sets uploaded by the *MadPad* community, or record a new set. *MadPad* thus turns the device into a central hub for both

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[87] At the time of this writing neither the ZooZ Radio feature or the 'Get New Beats' store have been functional. Attempts to obtain information from ZooZMobile support have been inconclusive. Based on press coverage it appears the nexus of activity for this app peaked in 2010, and while still functional, it seems that several features are not being maintained.
[88] Weinberg et al., *ZooZBeat*, 313.
[89] Smule, "Madpad."
[90] "MPC Series," inMusic Brands, accessed October 27, 2012, http://www.akaipro.com/mpc.

musical consumption and creation. It should be noted that, with this format of content distribution, there are at least three types of composition taking place. First, the user who creates and shares a set for others to perform is a composer in the sense that they select sounds and record them, then arrange them in a format ready for performance and reception. Second, the user who downloads a certain set and then performs with it has the ability to create their own sequences and compose songs with the set based on their own rhythmic choices and ordering of sounds. Third the app designers can be considered composers since they develop and author the code that permits these interactions with sound to take place. Within this group of participants the app designers also bear the closest resemblance to the romantic genius. Comparing the level of expertise required to write the code to the skill required to record video and perform within *MadPad*, the designers are the specialists, and are notably the only people within the *MadPad* community who receive a financial reward for their work. Though the music content is not commoditized, the app is.

In contrast to the prevailing system of content distribution that was based on the production of a physical commodity (vinyl records, tapes, and CDs), the content here is entirely digital, produced at minimal cost (save the purchase of the phone), and exchanged without any monetary compensation. As the community is mostly comprised of casual users, there is no thought to treat the music they produce as a commodity; the act of music-making is the reward.[91]

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[91] Kruge refers to *MadPad* as a type of 'casual media,' indicating a type of use and community base. In explaining how smartphones have been catalysts for this kind of musical engagement, Kruge notes, "The ubiquity factor is huge — and also the velocity at which these devices have spread. Over five years, there are already some tens of millions of them out there. So there's the ubiquity in that sense — but also in that your phone is always with you. I feel like these sorts of things just lend themselves to casual users; we've seen casual games take off, so it makes sense that casual media, whether with video interactivity like MadPad, or just music, will follow." Andy Cush, "How Smule's Product Alchemist Made the MadPad Reality Remixer," Evolver.fm, posted September 24, 2011, accessed October 27, 2012, http://evolver.fm/2011/09/24/how-smules-product-alchelmist-made-madpad-an-audiovideo-sampler-for-the-masses/.

The mobile app *RjDj* is yet another platform for music consumption and production, but it comes with its own market for producers to sell their work within the community after it has been vetted and selected for promotion by the *RjDj* team. *RjDj* operates under the same premise of interactivity as the aforementioned apps, and like *MadPad* is inspired by DJ culture. There are 'scenes' that can be downloaded and uploaded, each offering a different type of musical engagement. They are actually Pure Data patches specially made for mobile devices and formatted to run within the *RjDj* environment. On launching the app the home screen is divided into three scene choices: Soundtrips, Moovz, Interactive, plus a Featured icon that allows a user to find some of the more popular scenes. Soundtrips are designed to use the onboard mic to transform the user's environment into a musical experience, adding various effects such as delays and filters to the sound. Amplitude levels frequently trigger different types of effects depending on how high the signal is. This design lends itself well to a person on the go, perhaps walking along the street with phone in hand and listening with earbud speakers. Moovz are scenes that feature four instruments playing in a continuous loop, presented visually as four buttons. As the user touches one of the buttons, the corresponding instrument comes to the foreground in the mix, and will change in pitch, rhythm, and timbre depending on how the phone is tilted. The objective is to freestyle over a predetermined chord progression. Shaking the phone will bring about formal changes in instrumentation and harmonic progressions. For most Moovz that are produced and featured, the musical content is fairly predictable in terms of meter (usually 4/4), harmonic vocabulary (usually standard diatonic chord progressions), and scalar material (usually pentatonic or blues scales). Interactive scenes typically treat the screen as an xy-grid that, depending on the location of the coordinates, changes the timbre, volume, and pitch of the playing instrument. For example, Georg Bosch's the Interactive scene 'bouncy' provides a grid on which balls bounce across the screen and move with a gravitational pull according to the way the phone is tilted. The location of the balls affects the pitch of the pointillist soundscape. Within any scene, one can record the interactions, playback the

recording, give it a title, and share it via Facebook, Twitter, or email. The recording is posted to the *RjDj* online database with a dedicated URL, organized by user (if one opts to create an account) and the scene used.[92]

The *4Quarters* experience lies somewhere in between each of the aforementioned apps. Unlike *RjDj*, where the creation of scenes require a certain familiarity with Pure Data and other layers of code, content creators for *4Quarters* need not worry about mapping sounds to sensors, triggers, etc. The content that can be consumed in *4Quarters* comes in the form of audio files, which can be prepared on any digital audio recording setup. This is somewhat similar to *MadPad*, and the twelve-file visual layout with buttons serving as triggers also resembles *MadPad*. Though *4Quarters* does not currently provide a means for capturing audio samples to then use for sequencing, one can still record a playing session and share it. In its current state *4Quarters* also does not offer a seamless way to download audio from an online catalog as the other apps do—this is an attractive feature that will hopefully come in due time. Though *RjDj* and *MadPad* certainly provide ways for one-to-one interactions with artists from all over the globe, *4Quarters* functions best in small intimate group settings. Like *ZooZBeat*, the style of play in *4Quarters* caters to cooperative music-making in real-time.

In spite of the similarities shared between these apps, there is still a significant difference in how authorship and copyright issues are handled that separates *4Quarters* from *ZooZBeat*, *MadPad*, and *RjDj*. Unlike *4Quarters*, all content generated for use within these app environments is managed and authorized for sharing by the users who decide to post them to the community. The streamlined designs for each app do not permit loading samples other than what has been recorded by the user him/herself or by someone who has posted their own sounds for the express purpose of sharing. Because *4Quarters* handles any type of .wav or .aiff

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[92] For an example of an anonymous user's posted recording, see http://rjdj.me/recording/56634/, accessed October 27, 2012. As an aside, the scene 'Breathe,' created by Easy Star All-Stars, is a reggae iteration of Pink Floyd's "Breathe" from their iconic album *Dark Side of the Moon*.

file, there is no real limiting factor to prevent someone from loading copyright-protected material.

1.3.4 Ramifications of the Audience Becoming the Artist

As mobile technology advances our ability to share sounds and to appropriate material specifically designed for that purpose, the act of music-making becomes a focal point, but the artifacts tend to lose their significance. In taking stock of the actual output produced by these types of interactive mobile apps, it is not clear yet whether outstanding works of art will emerge. As many developers hasten the ability to leverage the phone's computational power and ubiquity toward engaging novice musicians, and as online storage is so cheap, there is an ever-growing amount of vast quantities of user-generated musical content. In many ways this is viewed as a good thing, as there are increased opportunities for music-making and creative stimulation without barriers of literacy or access. The ability to self-publish allows anyone with a phone and a desire to produce music to have a potential audience. Yet there are still many unresolved issues in terms of the reception of this content. It becomes difficult to present the work that is worth listening to amidst a sea of mediocre material. As most of this work is accessed online, there is little that can be done besides recommendation tools to help potential audiences in distinguishing quality. This problem is of course not unique to music, but affects all digitized art forms. In the next section, I will address the effect of information saturation, sampling practices, and the relationship between 'sound scavenging' and personalization.

1.4 Playlists, Mashups, and Sampling

1.4.1 Introduction

In its essence, *4Quarters* is a collaborative tool for remixing samples. On the outset one must choose what sound files will be stored into memory (up to 240 sound files), and then one selects the samples in real-time for playback. These activities are essentially forms of sampling,

and are not too distant from early remix practices associated with DJ culture. In *4Quarters* one performs with fully formed sonic objects by breaking them apart. This can dramatically realign time, thought, culture, and musical space through disruption. As *4Quarters* is another iteration of a remix tool, it is worthwhile to discuss various sampling practices as a way of exploring possible uses. In this chapter section I will discuss sampling theories presented by scholars looking to categorize different artistic treatments of samples. As *4Quarters* is tied to mobile devices as well as the desktop computer, I will also address the evolving nature of musical interactions with both, specifically addressing the role of ringtones, playlists, and mashups as acts of personalization, and as low-level forms of composition.

The term 'sampling' has been used to mean many different things. It can be a form of quotation, polystylism, collage, medley, paraphrase, variation, stylistic allusion, or parody (or sometimes several of these techniques at once). Though the discussion might easily encompass all forms of quotation and stretch back to include medieval cantus firmus settings in masses, I will limit my discussion to sampling of recordings, since this is what occurs with *4Quarters*. It is worth specifying that my use of the term 'sampling' here implies the manipulation of a prerecorded sound event in some way, either by breaking apart a portion of the material through truncation, or by altering the sound through technological means (distortion, altering playback speed, etc.).

1.4.2 The Impact of Technology on Sampling

With the advent of *digital* sampling, perhaps the most profound impact has not been the development of new techniques, but the democratization of sampling tools.[93] This is the result

[93] Technology has always had a profound impact on the musical output and aesthetics of sampling. Steve Reich's phasing techniques may never have developed had he not noticed how two tape players with the slightest difference in playback rate yielded an interesting sonic result when the two recordings slowly became out of phase. See K. Robert Schwartz, "Steve Reich: Music as a Gradual Process: Part I," *Perspectives of New Music* 19, no. 1/2 (1980), 384. DJ scratching techniques, which over time have become codified through various notations and

of three main factors: (1) greater access to equipment, (2) simplification of the sampling process, and (3) the collapsing of production and consumption of music to one device: the consumer computer or mobile phone. First, due to the cost of machinery early on, pioneering efforts with sampling typically came at the hands of the few people who had access to studio equipment. Over time the cost for hardware and software not only decreased, but computational power for consumer devices increased, allowing one to have access to studio-level equipment all neatly emulated within a software digital audio workstation (DAW) on a home computer. Second, the cutting, copying, and pasting process become a lot easier, less time-consuming, and also required less physical space. In comparing time required to cut and splice audio segments of magnetic tape with a razor, talcum powder and cellophane adhesive to the same task handled within a DAW via mouse and keyboard, the process can be digitally completed in a fraction of the time. The ability to hear the sonic results of the editing process changed from being a delayed reward for the dedicated studio musician to becoming a routine feature for anyone willing to poke around with audio software. Finally, in the digital domain the tool for consuming musical content is now generally the same tool for editing and producing content. As discussed in Section 1.3, this has profoundly impacted *who* produces the content and *how* people can change that content and repost new iterations. Remix became a widespread cultural practice with the development of the internet. In presenting some recent examples of YouTube remixes, Lawrence Lessig commented on this tremendous shift in cultural literacy as a function of democratization:

> I'm talking about people taking and recreating using other people's content, using digital technologies to say things differently. Now, the importance of this is not the technique that you've seen here. Because, of course, every technique that you've seen here is something that television and film producers have been able to do for the last 50 years. The importance is that that technique has been democratized. It is now anybody with access to a $1,500 computer who can take sounds and images from the culture around us and use it to say things differently. These tools of creativity have become tools of speech. It is a literacy for this generation. This is how our kids speak. It is how our kids think. It

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terms, are perhaps the most obvious examples of manipulative sampling techniques that are inextricably tied to the medium.

> is what your kids are as they increasingly understand digital technologies and their relationship to themselves.[94]

1.4.3 'Everything is a Remix'

"Nothing today, like nothing since we tamed fire, is genuinely new: Culture, like science and technology, grows by accretion, each new creator building on the works of those who came before."[95] In the video series *Everything is a Remix*, filmmaker Kirby Ferguson depicts numerous examples within popular culture—ranging from Edison's light bulb to Star Wars—as being transparently related to previous material. To drive the message home, Ferguson paraphrases seventeenth-century scientist Sir Isaac Newton's famous phrase "If I have seen further, it is by standing on the shoulders of giants," pointing out that Newton's words likewise paraphrase a similar utterance attributed to Bernard of Chartres dating back to the twelfth century.[96] In the ongoing battle over intellectual property as it relates to sampling, Ferguson's point is that remixing should be encouraged rather than curtailed by copyright laws. Lessig's overarching point is also in favor of adapting laws to accommodate what he views as a healthy cultural practice of remixing.[97] Both believe that remixing is at the heart of innovation.

Lev Manovich (2009), citing Michel de Certeau (1980; 1984), observed that the term 'remix' is applicable to other aspects of everyday life, since the act of rearranging and personalizing found objects is something we all do on a daily basis:

> "In modern societies most of the objects that people use in their everyday lives are mass-produced goods; these goods are the expressions of strategies of designers, producers, and marketers. People build their worlds and identities out of these readily available objects by using different tactics: bricolage, assembly, customization, and—to use a term that was not a part of de Certeau's vocabulary but that has become important today—

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[94] Larry Lessig, "Laws that choke creativity," 11:55.
[95] Ninth Circuit Court Judge Alex Kozinski, White v. Samsung Electronics America, Inc. 989 F.2d 1512, 1513 (1993), accessed September 28, 2012, http://wiki.lessig.org/Against_perpetual_copyright.
[96] kirby1, "Everything is a Remix, Part 2," February 2, 2011, video clip accessed July 16, 2012, Youtube, http://youtu.be/Z-HuenDPZw0.
[97] See Lawrence Lessig, *Free Culture: How Big Media Uses Technology and the Law to Lock Down Culture and Control Creativity* (New York: Penguin, 2004).

> remix. For instance, people rarely wear every piece from one designer as they appear in fashion shows; they usually mix and match different pieces from different sources. They also wear pieces of clothing in different ways than they were intended, and they customize the clothes themselves with buttons, belts, and other accessories. The same goes for the ways in which people decorate their living spaces, prepare meals, and in general construct their lifestyles."[98]

There are two important concepts here that I wish to highlight: first, 'people build their worlds and identities out of these readily available objects;' and second, the objects are refashioned 'in different ways than they were intended.' These two elements are closely tied to playlists, mashups, and to all forms of sampling.

1.4.4 Playlists

When one considers the evolution of mobile phones and portable mp3 players and how people have used them, Lessig's characterization of sampling—"taking and recreating using other people's content… to say things differently"—also applies to forming playlists and selecting ringtones. The first generation of mobile phones and portable devices allowed everyday people to interact with mobile music through selection. First it was the selection of downloadable ringtones, allowing one to personalize their phone. It could also be an act of establishing one's identity through personalization—making statements and communicating something about one's persona. What we do with these objects is a form of bricolage; we assemble various things to personalize and form our identity.

The iPod and other portable music devices act as an extension of this concept of collage. Prior to mobile phones, the Walkman—with radio, tape, or CD playback—provided the same basic set of controls to shape one's musical experience. As mass storage of entire CD collections onto a portable hand-held device became possible, organizing the collection became a main feature of one's experience with the device.[100] The assembly of unique playlists, similar to the

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[98] Lev Manovich, "The Practice of Everyday (Media) Life: From Mass Consumption to Mass Cultural Production?" *Critical Inquiry* 35, no. 2 (2009), 322-23.

[100] The ability to randomize playback is yet another significant feature offered on these devices, which removes the user's responsibility for choosing from an overwhelming abundance of

'mix tape' but far less labor-intensive, became a popular activity. Since 2003 Apple has posted celebrity playlists on iTunes as a means of promoting their devices, the store, and educating customers about how to use their products.[101] Walking playlists, party playlists, playlists for cooking, for Sunday mornings… one might make a statement about who we are by making a playlist and sharing it. One might also use the playlist to create aural backdrop—similar to wallpaper—to use while doing something else. The assembly of the playlist—scavenging through an entire collection and selecting bits and pieces—is a very basic form of meta-composition, but is nevertheless a true creative act. It permits the owner of the device to have many new opportunities and spaces in which to share their selections because of the mobility of the device.

The assembled playlist on a mobile phone has striking similarity to Marcel Duchamp's 'readymades,' and his aesthetic of the creative act: selection and personalization of mass-produced artifacts. Consider the following explanation of the readymade by Thierry de Duve:

> "…When we deal with a readymade, we must consider that both the object and the artist are given, that they exist independently of each other, and that the 'work,' or the 'art,' results from their encounter: 'The readymade is a kind of rendezvous,' said Duchamp himself. So, the object's reclassification as art is one with the artist's respecification as the author of the work, and they both stem from a triple act: choosing, naming, signing."[102]

Though most people do not classify the playlist as a work of art, one cannot ignore the similarities between Duchamp's artist/object relationship and the relationship of the playlist creator to the songs. We choose songs that exist independently, name the playlist (a necessity in order to create a file on a computer), and effectively sign it when we share it.

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choices. Though this is yet another important feature, it is still a subsidiary option to the main interaction, which is the maintenance of the collection.

[101] See Dan Kois, "Beyoncé, Your Mix Tape Sucks: The Perils of iTunes celebrity playlists," *Slate.com*, May 26, 2004, accessed September 27, 2012, http://www.slate.com/articles/arts/culturebox/2004/05/beyonc_your_mix_tape_sucks.html.

[102] Thierry De Duve, "Authorship Stripped Bare, Even," *RES: Anthropology and Aesthetics* 19/20 (1990/91): 235.

1.4.5 Mashups

Remix of existing sound sources can take a variety of forms. Whereas the playlist is a set of songs from disparate sources intended for one contiguous sequence of unaltered playback from one song to the next, the mashup is one particular style that superimposes two or more sources that are easily recognizable as simultaneous layers of one new creation.[103] Like the playlist, the recognition of the original sources is intrinsic to the exercise, but here the sources are deliberately altered and modified to play with the listener's expectations. The effectiveness of an artist's mashup is frequently measured by how different the second take is from the originals.

One clever example is "A Stroke of Genie-us," produced in 2001 by DJ Roy Kerr, featuring Christina Aguilera's lyrics from "Genie in a Bottle" mashed with instrumental sections of "Hard to Explain" by the Strokes.[104] DJ Party Ben's mashup "Single Ladies (In Mayberry) (Beyoncé vs. 'The Andy Griffith Show' Theme)" (2009) is another popular example.[105] As is the case with these two examples, mashup artists will frequently make the sources clear in the title of the work, or at least reference them.

The Grey Album (2004) by Brian Burton (better known as Danger Mouse) is a prime example, and possibly the most famous. Two albums of similar names—Jay-Z's *The Black Album* and The Beatles' *White Album*—, both landmark albums in their own right, were collapsed to form *The Grey Album*. Burton acquired the a cappella version of *The Black Album*,

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[103] Mashups have different meanings in popular culture, depending on the type of technology used and their function. Navas (2007) points out that mashups in web 2.0 applications usually consist of taking application programming interfaces (APIs) and adding a specific type of functionality to meet a narrow audience (like Metrolink lines plotted on a Google Map). Eduardo Navas, "Regressive and Reflexive Mashups in Sampling Culture," *Vague Terrain*, June 24, 2007, accessed September 28, 2012, http://vagueterrain.net/journal07/eduardo-navas/02.

[104] Ibid. A copy of this mashup can be viewed on Youtube. See Brian Mazzarella, "The Strokes Vs Christina Aguilera – A Stroke Of Genie-us," September 18, 2007, video clip, accessed September 28, 2012, Youtube, http://www.youtube.com/watch?v=ShPPbT3svAw.

[105] Party Ben makes the mashup publically available on his site. Visit http://www.partyben.com/PartyBen-SingleLadies(InMayberry).mp3 (accessed September 28, 2012).

then the beats per minute (BPM) for each track, and began a long process of listening to every strike of a drum or cymbal crash from the thirty tracks on *The White Album*. Drum samples extracted from the Beatles tracks—mostly single hits rather than extended segments—were aligned to the BPM grid of Jay-Z tracks to create the beat to support the lyrics. Burton then repeated the process to find guitar and bass samples.[106]

At first glance the album may appear to have a clear subtext about race. In the finished product, Jay-Z's lyrics are mostly unchanged while the Beatles samples are consistently subverted; yet Burton did not create the project with cultural clashes in mind. Burton says, "My whole thing with this was I didn't want to mess up the Beatles song either. I don't want to disrespect the Beatles. A lot of people thought it was sacrilege in the first place. I knew that would be something, but I didn't know it was going to be [distributed] on a wide scale. I knew my friends wouldn't think it was sacrilege, so I just made sure it was something I would dig myself."[107] Nevertheless, Kevin Holm-Hudson notes, "Intentionally or not, the sample in popular music bears the weight of its original context."[108] The irony of the Beatles' music being appropriated into a style largely associated with black culture was not lost on Paul McCartney:

> It was really cool when hip-hop started, you would hear references in lyrics, you always felt honored. It's exactly what we did in the beginning – introducing black soul music to a mass white audience. It's come full circle. It's, well, cool. When you hear a riff similar to your own, your first feeling is 'rip-off.' After you've got over it you think, "Look at that, someone's noticed that riff."
>
> I didn't mind when something like that happened with The Grey Album. But the record company minded. They put up a fuss. But it was like, "Take it easy guys, it's a tribute."[109]

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[106] Corey Moss, "*Grey Album* Producer Danger Mouse Explains How He Did It," *MTV News*, March 11, 2004, accessed September 28, 2012, http://www.mtv.com/news/articles/1485693/grey-album-producer-explains-how-did-it.jhtml.
[107] Ibid.
[108] Kevin Holm-Hudson, "Quotation and Context: Sampling and John Oswald's Plunderphonics," *Leonardo Music Journal* 7 (1997): 18.
[109] These quotes were from a BBC Radio 1 documentary entitled *The Beatles and Black Music*, produced by Vivienne Perry and Ele Beattie and aired Sunday 31st, October 2010. While the documentary is no longer available (see http://www.bbc.co.uk/programmes/b00vfgvw (28 September, 2012)), the quotes here are posted on several websites (see http://www2.gibson.com/News-Lifestyle/News/en-us/dangermouse-0224-2011.aspx (28 September, 2012)).

EMI ensured that *The Grey Album* was never produced, though it remains a cult classic among bootleggers.[110] In McCartney's quote we see two cultural orientations at odds over the nature of sampling: the record company (EMI, in this case) representing a Western European tradition that links authorship to ownership, and McCartney representing (or recognizing) an African-American tradition that links authorship to a community and historic past. This concept of quotation as tribute is an important aesthetic with the mashup in particular; the recognition of the original sample is partly a veneration of the past. Self argues that sampling can be motivated by a desire for contribution to a tradition in a folkloric sense: "In many ways, the practice of sampling is very much a contemporary demonstration of the folk music tradition… Folk music originates in oral cultures, i.e., societies in which structure, formula, and repetition are used to aid in the transmission of messages—in stories, poems, and songs—from generation to generation."[111]

1.4.6 Sampling Practices

Thus far I have only included examples where the source of an original sample is made explicit to the listener in the remixed version. Although DJ culture emerged with this attitude of veneration of original artists, not all sampling practices embrace the 'aura of the past.' I will now examine various sampling treatments as well as proposed categorizations in the hope of providing possible performance approaches with *4Quarters*.

According to Eduardo Navas, there were three main types of remix that initially emerged from the 1970s disco scene and from DJ-based music settings. The first type was the *extended* remix, where the purpose for appropriating other people's content was to create longer versions

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[110] Joseph Patel, "Producer of *The Grey Album,* Jay-Z/Beatles Mashup, Gets Served," *MTV News*, February 10, 2004, accessed September 28, 2012, http://www.mtv.com/news/articles/1484938/producer-jay-z-beatles-mashup-gets-served.jhtml.

[111] Henry Self, "Digital Sampling: A Cultural Perspective," *UCLA Entertainment Law Review* 9, no. 2 (2002), 354.

of songs or continuous medleys of several songs for dance parties. The second version was a *selective* remix, consisting of adding or subtracting parts from the initial source but preserving the aura of the original song. The third version was *reflexive* remix; "it allegorizes and extends the aesthetic of sampling, where the remixed version challenges the aura of the original and claims autonomy even when it carries the name of the original."[112]

David Sanjek classified sampling into four categories, based on the degree one could recognize the original source. First, there are samples "of sufficient familiarity so that the listener may recognize the quotation and may, in turn, pay more attention to the new material as a consequence of that familiarity".[113] This description would match the aesthetics of the mashups described in Section 1.4.5, as well as Navas's *extended* and *selective* remixes. Of course, recognition of a sample is entirely dependent on the listener and may vary from person to person. The second category includes songs made from "both familiar and arcane sources, thereby attracting a level of interest equal to the lyric content."[114] The third category is the collage-like technique in which "recordings can be constructed wholecloth from samples to create a new aesthetic." This type of sampling includes pieces that are completely constructed from samples, but refashioned in such a way that the original source is completely transformed. A perfect example of this would be John Oswald's 'plunderphonic' pieces.[115] "Sanjek's fourth category highlights the kind of sampling that is contracted by artists to sampling artists such as Moby, Trevor Horn, and Rick Rubin for the purpose of generating alternative remixes that feature new music underneath the original vocal line."[116]

Chris Cutler's proposed taxonomy for categorizing sampling practices includes five categories: "There It Is," "Partial Importation," "Total Importation," "Sources Irrelevant," and

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[112] Navas, "Regressive and Reflexive Mashups."
[113] David Sanjek, "'Don't Have to DJ No More': Sampling and the 'Autonomous' Creator," in *The Construction of Authorship: Textual Appropriation in Law and Literature*, eds. Martha Woodmansee and Peter Jaszi (Durham: Duke University Press, 1994), 349.
[114] Sanjek, "'Don't Have to DJ No More'," 349.
[115] See Holm-Hudson, "Quotation and Context."
[116] Ibid., 19.

"Sources Untraceable."[117] Examples of the "There It Is" include Pierre Schaeffer's early *musique concrète* pieces and John Cage's *Imaginary Landscapes 2* and *4*, *Radio Music*, or *Williams Mix*. These pieces deliberately avoid any narrative structures in an effort to free sounds from carrying embedded messages. "Partial Importation" involves works in which a quotation is used prominently as a centerpiece around which the rest of the music is constructed. This may be the combination of newly created instrumental or vocal tracks alongside the featured quotation. The example Cutler uses to illustrate this is *My Life in the Bush of Ghosts* (1981) by David Byrne and Brian Eno. "Total Importation" involves a complete reordering of events within a sampled source to become a wholly new artistic work. The sourced sample may be recognizable, but it is transformed so completely that one could not mistake the derivative work for the original. Cutler places John Oswald's groundbreaking 'Plundephonics' pieces here. By contrast, "Sources Irrelevant" might describe scenarios in which there is no self-reflexivity involved in the listening process; that is the original sample is treated as raw material. DJ Spooky (also known as Paul Miller) writes in the CD liner notes of his album *Songs of a Dead Dreamer* (1996): "Each and every source sample is fragmented and bereft of prior meaning – kind of like a future without a past. The samples are given meaning only when represented in the assemblage of the mix."[118] This kind of treatment aligns closely with the sampling techniques found in Beck Hansen's album *Odelay* (1996), where dozens of samples are added in collage-like manner with little reference to origins. Cutler adds, "Also within this category falls the whole mundane universe of sampling or stealing 'sounds': drum sounds (not parts), guitar chords, riffs, vocal interjections etc., sometimes creatively used but more often simply a way of saving time and money."[119] Several scholars have problematized this "Sounds Irrelevant" approach. Tara Rodgers (2003) succinctly describes the issues at play:

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[117] Chris Cutler, "Plunderphonia," 1994, accessed September 28, 2012, http://www.ccutler.com/ccutler/writing/plunderphonia.shtml.
[118] See Tara Rodgers, "On the process and aesthetics of sampling in electronic music production," *Organised Sound* 8, no. 3 (2003): 318.
[119] Cutler, "Plunderphonia."

> As Timothy Taylor has argued, many contemporary electronic musicians tend to view samples as disembodied raw material, or 'extremely aestheticized bits of sound', simply part of the overall sonic mix (Taylor 2001: 150–5). While hip hop artists typically employ samples to accomplish what Rose has described as 'cultural literacy and intertextual reference', other electronic musicians' 'taking' of musical samples can amount to a sort of sonic colonialism, whereby aural fragments are used for perceived 'exotic' effect, without investment in, or engagement with, the music culture from which the sample was gathered (Rose 1994: 89; Taylor 2001: 136–54).[120]

Within Cutler's last category, "Sources Untraceable," the original source is manipulated beyond any ability for one to trace the sources. This aesthetic was undertaken in John Oswald's *Plexure* (1994), where thousands of samples were juxtaposed in short enough increments that it renders the ability to recognize the sources impossible. Cutler states,

> "Within this use lies a whole universe of viewpoints. For instance, the positive exploration of new worlds of sound and new possibilities of aestheticisation – or the idea that there is no need to originate any more, since what is already there offers such endless possibilities – or the expression of an implied helplessness in the face of contemporary conditions, namely, everything that can be done has been done and we can only rearrange the pieces."[121]

In this context, the concept of originality is completely neutralized. Holm-Hudson states, "The creator of a sampled-sound piece, therefore, is ultimately merely an arranger, pasting together fragments of a musical history in such a way that the total exceeds the sum of the quotes. But this is arguably what any composer does."[122]

1.4.7 Conclusion

Remix continues to challenge what is meant by composition and what is meant by creativity. When sampling merges the documenting device with a creative device, old definitions and frameworks fail to frame the experience. In John Oswald's landmark address

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[120] Tara Rodgers, "Process and Aesthetics of Sampling," 318. See also Timothy D. Taylor, *Strange Sounds: Music, Technology, & Culture* (New York & London: Routledge, 2001); Tricia Rose, *Black Noise: Rap Music and Black Culture in Contemporary America* (Hanover & London: Wesleyan University Press, 1994).
[121] Cutler, "Plunderphonia."
[122] Kevin Holm-Hudson, "Quotation and Context," 20.

"Plunderphonics, or Audio Piracy as a Compositional Prerogative," he summarized the issue of creating a new performance from a recording device:

> A phonograph in the hands of a hip hop/scratch artist who plays a record like an electronic washboard with a phonographic needle as a plectrum, produces sounds which are unique and not reproduced - the record player becomes a musical instrument. A sampler, in essence a recording, transforming instrument, is simultaneously a documenting device and a creative device, in effect reducing a distinction manifested by copyright.[123]

4Quarters does this same thing. Additionally, I aim to reclaim a social aspect in terms of creation, not just in the relationship between the sampled object, its creator, and the person remixing, but also with a social collaborative between peers in real-time performance. Again, this draws away the attention from the composers whose artifacts are selected and imported to *4Quarters*, but to the creative interaction in real-time between players. This aspect, in my opinion, is new compared to the sampling practices I have described here, and is made possible through networking technologies. In the next chapter, I will examine network music in its various iterations.

[123] John Oswald, "Plunderphonics, or Audio Piracy as a Compositional Prerogative," 1985, accessed September 28, 2012, http://www.plunderphonics.com/xhtml/xplunder.html.

CHAPTER 2. NETWORK MUSIC: HISTORY AND CONCEPTUAL MODELS

2.1 A Timeline

2.1.1 Introduction

As mobile phones are inherently networked devices, they belong to a longer history of networked music and art, and in many instances can be viewed as relatively new tools that simply extend well-formed aesthetic approaches to technology, geography, and social collaboration as they pertain to music. At the same time, mobile phone music—which at this point is roughly a decade old—is beginning to have a history of its own, with commentaries, frameworks, and ideas that are unique to the handheld devices. There are also distinctions one can make about artworks as the technology has evolved, especially when one considers the change in sonic output from ringtones (simple playback) to far more rich uses. In this section, I aim to embed the history of mobile phones within the context of network music and its history by giving a brief explanation of existing efforts made to catalogue network music. I will then outline the history of mobile phone music as a basic point of departure for subsequent sections within this chapter and Chapter 3. As there are an ever-increasing number of mobile music works (and frequently these are still on the sidelines of popular awareness), my aim is not to provide a tally of the growing body of existing mobile music works but rather to illustrate pieces that exemplify the main ways in which mobile phones have been used in musical contexts to date.

2.1.2 Existing Archiving Efforts

The term 'network' has obvious association with the internet, and it has been generically attached to any musical work that uses web-based technology. As scholars have looked at the purposes or the outcomes achieved by the growing corpus of works using internet-based networks, it has been easy to find historical precedents. When one looks at the purposes of

networks, rather than limiting the survey to the vehicle of transmission, one can find similarities to a vast host of works dealing with sound and distance throughout history. Depending on how one defines it, network music—that is, music that leverages networking capabilities, sound displacement over great distances, or remote performance—has a long history that predates current broadcasting technologies, the internet, mobile phones, or even the term 'network' itself.[1] The most comprehensive effort to document and archive networked sound art in a chronological fashion was initiated by Jérôme Joy in 2008, eventually enlisting a large group of co-contributors to form the *Networked Music & Sound Art Timeline*.[2] It is currently published online in PDF format as a set of five volumes. The first volume concerns ancient history and anticipatory literature, with the first entry dating to ca 3500 BC (citing the origins of 'auditing' being an early form of data sonification). The invention of the tuning fork, telephony, radio, and various 'firsts', along with records of musical events using spatially separated ensembles, are all documented in this prodigious undertaking.

In looking toward efforts with time spans limited to the last decade, there are several online blogs that have provided invaluable visibility to relatively small and localized network-centric artworks across the globe. *Networked Music Review*, *Rhizome*, and Régine Debatty's *We Make Money Not Art* are the best-known blogs devoted to publicizing network-based art.[3] In efforts to document artworks exclusively featuring mobile devices and sound, Golan Levin's

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[1] Though it may seem like selective history to map current ontologies onto older ones, Joy & Sinclair and Behrendt link the present to past with a spirit of tempering enthusiasm for new technologies and their supposed unprecedented potential. See Pedro 4/4/13 4:49 PM *Contemporary Music Review* 28, nos. 4-5 (2009): 387-393; Jérôme Joy and Peter Sinclair, "Networked Music & Soundart Timeline (NMSAT): A Panoramic View of Practices and Techniques Related to Sound Transmission and Distance Listening," *Contemporary Music Review* 28, nos. 4-5 (2009): 351-361; Frauke Behrendt, "Towards a history of mobile phone arts," November 7, 2009, posted July 11, 2010, video clip, accessed January 22, 2013, http://vimeo.com/13242419.

[2] Jérôme Joy et al., "NMSAT Timeline," last modified September 6, 2012, accessed October 9, 2012, http://joy.nujus.net/w/index.php?page=NMSAT.en.

[3] Jo-Anne Green and Helen Thorington, *Networked Music Review* (blog), http://turbulence.org/networked_music_review/; *Rhizome* (blog), http://rhizome.org; Régine Debatty, *We Make Money Not Art* (blog), http://we-make-money-not-art.com/.

Informal Catalogue of Mobile Phone Performances, Installations, and Artworks and Frauke Behrendt's blog *Mobile Sound* have been useful resources.[4] The Mobile Music Workshop, a community that has convened from 2004-2008, published the works presented there in a compendium entitled *Creative Interactions - The MobileMusicWorkshop 2004 – 2008*.[5]

As Behrendt notes, network music (and mobile music in particular) has been historically a matter of three main artistic concerns or points of emphasis: technological, social, and geographic contexts.[6] When assessing the history of music or sound art made with mobile phones, it is important to bear in mind all three elements. Behrendt states,

> It is not helpful to design fixed categories along these three contexts, because for every artwork the social context as well as the technological and geographical context needs to be analysed. Still most examples tend to engage stronger with one of them. Therefore it makes sense to classify artworks depending on their focus on the technological, the social or the geographic context – as long as one bears in mind the other contexts as well. The danger of separating them is to forget that these aspects influence each other.[7]

With this in mind, in this section I will focus primarily on a chronological history of mobile music, tracing major technological advancements as a means of providing continuity to a range of diverse works. I will not create a chronological list of all mobile phone musical works, as many are small in scope and impact. Instead, I will give a broad overview of major breakthroughs in technology and works that incorporated them, with particular attention to the transition from fixed to mobile technologies. In subsequent sections I will distribute works into categories based on the emphases Behrendt suggests.

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[4] Golan Levin, "Informal Catalogue of Mobile Phone Performances, Installations, and Artworks," *Flong*, September 2001, accessed October 9, 2012, http://flong.com/texts/lists/mobile_phone/; Frauke Behrendt, *Mobile Sound: Sound, Mobile Media, Art & Culture* (blog), accessed January 24, 2013, http://mobilesound.wordpress.com/.
[5] Nicolaj Kirisits, Frauke Behrendt, Layla Gaye, and Atau Tanaka, (eds.), *Creative Interactions – The Mobile Music Workshops 2004-2008* (Vienna: University of Applied Arts, 2008).
[6] Frauke Behrendt, "From Calling a Cloud to Finding the Missing Track: Artistic Approaches to Mobile Music," in *Proceedings of the NIME Mobile Music Workshop*, Vancouver, Canada, 2005;
[7] Ibid.

2.1.3 Mobile Music History - Precedents to Mobile Phone Music

Mobile music—that is, music made 'on the go'—has existed for quite a long time. Marching bands, troubadours, and carolers are all examples of music ensembles tailored specifically for mobility. Parades and processions have longstanding traditions as social events with music passing by a stationary crowd. Hand-held instruments like the flute or the trumpet have lent themselves well to portability, while less-portable instruments have in some cases been modified to become portable. In such cases, there are trade-offs involved. For instance, in adapting a standard drum kit (including kick drum, toms, snare, and cymbals) for marching band the full kit is parsed into the hands of several drummers, each needing special harnesses. This same concept can be applied to the adaptation of modern recording playback devices such as the radio, tape recorder, and CD player into mobile formats, where the boom box or Walkman offer portability but compromise fidelity and frequency response relative to immobile stereo systems. In this sense mobile phones today are simply more portable versions of telephones, yet with the integration of relatively powerful central processing units with internet and GPS capabilities, they are also now portable versions of computers, although with less computational power and storage capacity, and, again, limited sound quality.[8]

The first well-known instance of using telephone lines for musical purposes dates back to Thaddeus Cahill's Telharmonium, a colossal project at the turn of the twentieth century that predates amplification technology, radio technology, and was the first attempt at broadcasting music to the masses.[9] The Telharmonium was essentially an additive synthesis instrument linked to the existing telephone system, broadcasting music to various locations within New

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[8] This assumes that the phone is compared to its contemporary equivalent. Phones today far exceed the capacity and computational power of computers in the past that seemed revolutionary at the time. An iPhone 5—released in 2012—offers a maximum of 64GB storage, which is roughly double the capacity of my first laptop's hard drive that I purchased in 2002, the Apple Powerbook G4 'Titanium.'

[9] In Reynold Weidenaar, *The Telharmonium: A History of the First Music Synthesizer, 1893-1918,* Ph.D. dissertation, New York University, 1988, Weidenaar chronicles three decades of antecedent uses of telephone technology to transmit acoustically generated sounds.

York City, but the vision was to allow for even greater distribution across cities. It was met with tremendous enthusiasm and popular appeal before suffering from technical difficulties (such as crosstalk interference) and financial panic. It was widely viewed as a failure, even though the ideas behind it have proven to be prophetic. Here the telephone was not used as an instrument, but as an interface or medium for musical performance.

As radio broadcasting became a viable format for broadcasting and was well situated as a one-directional medium (or many-to-one nodes within a network), John Cage thought to use the radio as a musical instrument rather than as medium. In *Imaginary Landscape 4* (1951), Cage composed an indeterminate work for 24 performers and twelve radios, each radio played by one person controlling the tuner dial and another adjusting the volume. This is an important precedent for considering the mobile phone as a musical device, and for appropriating found objects into originally unintended musical contexts.

Max Neuhaus's radio and telephone works *Public Supply* (1966, 1968, 1973) and *Radio Net* (1977) were important network pieces that anticipated the types of civic engagement that mobile phones offer today. In *Public Supply I,* conducted in cooperation with WBAI radio in New York City, Neuhaus invited listeners to call into the radio station switchboard and make noises over the phone, which would then be mixed at the switchboard by Neuhaus and broadcast live over the radio. The purpose was to create an 'aural space' of approximately twenty miles for musical communication. In subsequent iterations of the same idea, different stations across the United States were linked together, culminating in a six-city effort for *Radio Net,* coordinated by NPR in Washington, DC, with call-centers established in New York, Atlanta, Dallas, Minneapolis, and Los Angeles. While this is very much a socially-oriented piece and a milestone in audience-participatory music, it is also very much an attempt to overcome the one-directional nature of broadcast media and its residual effects. Neuhaus reflected,

> ...It seems that what these works are really about is proposing to reinstate a kind of music which we have forgotten about and which is perhaps the original impulse for

> music in man: not making a musical product to be listened to, but forming a dialogue, a dialogue without language, a sound dialogue.[10]

This desire to use technology to facilitate music as activity rather than to let technology create passivity is one of the main aesthetic purposes of mobile phone music.[11] In both instances, the phone is leveraged for its ubiquity and anonymity, therefore empowering everyday people to participate.

In 1969 the Chicago Contemporary Museum of Art presented an exhibition called *Art by Telephone*, inviting thirty-six artists to call in instructions on what they would like their contributions to be, which would then be realized by the museum staff.[12] The emphasis here was clearly routed in demonstrating remote-controlled art via the telephone, yielding mostly uninteresting results. However, one work by Robert Huot "potentially involved all visitors of the museum and attempted to generate unexpected first meetings by employing chance and anonymity."[13] Using the alphabetized phone book as a point of departure, Huot selected twenty-six U.S. cities, one for each alphabet letter, and then found telephone numbers of twenty-six men, each named Arthur, but with last names matching up with the city (e.g. Pearson, Philadelphia). The Museum posted the listings and corresponding phone numbers and encouraged visitors to ask for "Art." The work then became the spontaneous conversation that would arise. Souza e Silva writes,

> Huot's piece presents the artist as the creator of a context, in which the visitor participates in the creative process. Here the telephone is used to turn artmaking into a social experience. Generally, up until the end of the 1990's artworks that used telephone handsets were almost all restricted to calling another party, using the phone's ring as an artistic element, and recording voice messages.[14]

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[10] Max Neuhuas, "The broadcast works and Audium," in *Zeitgleich: The Symposium, the Seminar, the Exhibition*, ed. Heidi Grundmann (Vienna: Triton, 1994), accessed October 7, 2012, http://www.max-neuhaus.info/bibliography/.
[11] Here I use 'mobile phone music' to indicate a unique genre of music. Further elaboration follows in this section and in section 2.1.5.
[12] Adriana de Souza e Silva, "Art by Telephone: from static to mobile interfaces," *Leonardo Electronic Almanac* 12, no. 10 (2004): 5.
[13] Eduardo Kac, in Souza e Silva, "Art by Telephone," 4.
[14] Souza e Silva, "Art by Telepone," 5.

In the late 1970s The League of Automatic Music Composers, a group comprised of John Bischoff, Jim Horton, and Rich Gold (later replaced by Tim Perkis) based in Oakland, California, was the first to use the commercial desktop computer to write interdependent music compositions. Perhaps more importantly, they were one of the first to use computers to perform live.[15] Up until this point computers were mainly used for the production of 'fixed media' pieces for playback. Their objective was to exploit the creative possibilities of each person being able to modify the other's musical content via network connection. As this group later formed The Hub in 1986 and networking possibilities became more robust, remote performance became an interest.

Franziska Schroeder provides a brief overview of networked music practices since The League of Automatic Music Composers formed, noting that since 2004-2006 there has been a significant increase in networked performance practices.[16] This has largely been due to the development of high-speed backbones such as Internet2 (http://www.internet2.edu) in the United States, permitting real-time high-quality interactive audio. Equally important are the developments of platforms to leverage these capabilities by institutions and "increased recognition of net art within the context of arts/research funding bodies."[17] Some important platforms have been The SoundWire project, MUSE (Multi-User Studio Environment), LiveJam, Quinet.net, CO-ME-DI-A, JackTrip, and Soundjack.[18] These developments have greatly pushed forward the ability to conduct long-distance performances live online. In the process the concept of live network performance has been legitimized, and ensembles based on

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[15] Roger Mills, "Dislocated Sound: A Survey of Improvisation in Networked Audio Platforms," in *Proceedings of the 2010 Conference on New Interfaces for Musical Expression (NIME 2010)*, Sydney, Australia, 186-191.
[16] Franziska Schroeder, "Dramaturgy as a Model for Geographically Displaced Collaborations: Views from Within and Views from Without," *Contemporary Music Review,* 28 no. 4 (2009): 377-385.
[17] Ibid., 379.
[18] Ibid., 377-78.

local area networks such as laptop orchestras have been precursors for mobile phone orchestras using similar network layouts.

The establishment of the Global Positioning System (GPS), today mostly associated with mobile hand-held devices, became a primary interest in the compositions of Marek Choloniewski. Since 2000 he has created 'sound maps' in his hometown of Krakow, Poland. "With a small group of assistants, he has been driving a car through the streets, tracking his progress, phoning sounds in to the studio from various locations, and allowing the car's route to trigger prerecorded city sounds along the way."[19] Choloniewski includes GPS in the titles of most of his works, stating that the receiver and the satellite infrastructure form a "global interactive instrument" that handles both the creation and processing of audio and visual material.[20] Several artists since have developed this form of motion-based music on a large outdoor scale, using the web and GPS to form 'mediascapes,' sound walks, or 'geotagged' projects. Of interest here is that Choloniewski used the car as the 'playing finger' instead of a handheld mobile phone, which had yet to include GPS integration.[21] We might say the work could be realized either way—it is not the size or form of the receiver that characterizes this type of work.

When considering the mobile phone specifically, 'mobile phone music' belongs to several categories of music that overlap but do not necessarily rely on mobile phones in order to be effective. We might imagine the music made with this device to be in the middle of several overlapping circles (see Figure 2.1). Mobile phone music belongs to Souza e Silva's categorization 'telephone art,' which includes both landline telephones in fixed locations and mobile phones. It is part of mobile music but not a defining characteristic of mobile music, as Choloniewski's pieces demonstrate. It is also circumscribed in network music, and starting around 2004 has become integrated in internet-based music arts (for example, 'flash mobs' have

[19] William Duckworth, *Virtual Music: How the Web Got Wired for Sound*, 112.
[20] Ibid., 112.
[21] Ibid., 114.

been certainly been spurred by mobile devices but have been organized through other means in the past).[22] At what point then has the mobile phone been an indispensable or crucial element in the success of a given work of art? It wasn't until 2000 that the mobile phone—and not some other device—became an intrinsic element in a musical work.

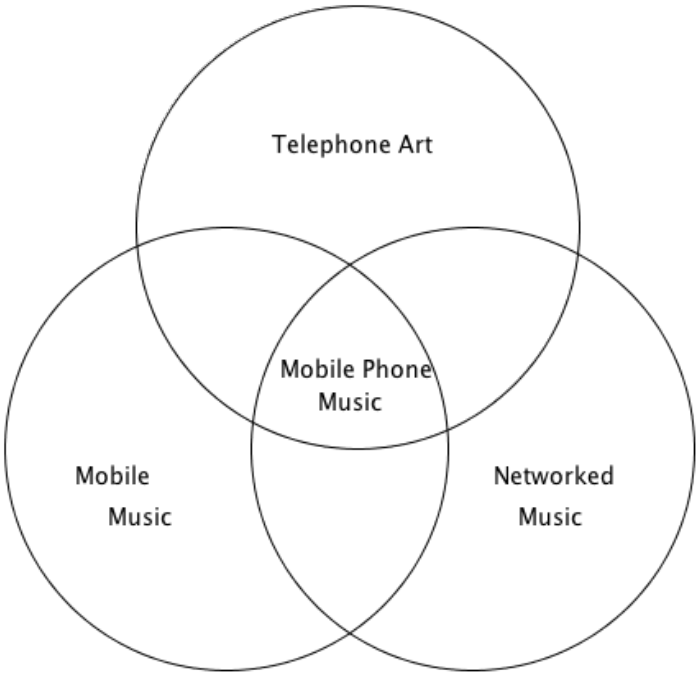

Figure 2.1. Mobile phone music is part of three concurrent traditions

[22] Artist collectives such as Ligna and Improv Everywhere have organized mob scenes using the internet to organize the events, but in the performance realization have used radio (Ligna's *Radioballett* (2003)) and mp3 players (Improv Everywhere's *Mp3 Experiments* (2004-2012), respectively. See Ligna, "Radio Ballett Leipzig Main Station Part I," January 27, 2008, video clip, accessed October 7, 2012, YouTube, http://youtu.be/qI3pfa5QNZI; and Improv Everywhere, "The Mp3 Experiments," accessed October 9, 2012, http://improveverywhere.com/missions/the-mp3-experiments/.

2.1.5 Mobile (Phone) Music – Before Smart phones

Alison Craighead and Jon Thompson's *Telephony* may be the first mobile phone musical work, presented in October 2000 at Mobile Home Gallery in London (now closed).[23] In the work, 42 Siemens phones were mounted on a wall with different preprogrammed ringtones all fashioned after the popular and prevalent NokiaTune. More than anything else, it is the musical content that makes this piece a *mobile phone* work. The NokiaTune is associated with cellphones (not telephones) and became popularized due to the widespread proliferation of the ringtone in daily life. Gallery visitors could call the wall, setting off a chain of internal calls from one phone to the next, creating a piece of music with various textures and harmonic layers. Multiple callers from within or without the gallery could create multiple triggers and thus form a denser texture. Similar installation pieces the same year appeared at the Hannover Expo at the Nokia Finland Finnish Pavilion Exhibit and with Usman Haque's *Japanese Whispers* in Tokyo, Japan, both of which feature clusters of phones playing ringtones in various patterns. [24] Haque's piece arrayed the phones in a circle, using the phone's input microphone to pick up ambient sounds and visitor's voices in the gallery to create feedback loops.

In 2001 several composers addressed the growing ubiquity of mobile phones in everyday life—meaning not only that everyone has one but also that the devices are always with us—and its penetration in the concert hall by incorporating ringtones into the performances. On June 1st at the Bloomfield Science Museum in Jerusalem, *Spring Cellphony* was performed as a mobile phone concerto with "a large symphony orchestra …accompanied by recorded phone sounds."[25] The 10-minute medley of classical tunes begun with the *William Tell Overture* played as a

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[23] Email exchange with Alison Craighead and Jon Thomson. See also Jon Thomson and Alison Craighead, "Telephony," *Thomson & Craighead*, accessed October 9, 2012, http://www.thomson-craighead.net/docs/teleph.html.

[24] Levin, "Catalogue of Mobile Phone Performances."

[25] "Orchestra performs first mobile phone symphony," *Ananova,* 2005, accessed October 9, 2012, http://web.archive.org/web/20050207002143/http://www.ananova.com/entertainment_quirky/story/sm_312997.html.

ringtone, later featuring tunes by Bach, Mozart, and others. As a bit of social commentary, the piece ended with a cellphone ringing in the audience as a planned interruption. Other pieces written with in the same vein include Tobias Trier's *MobilSymfoni* (2001), Simon Turner and Marcus Moore's *New Ring Cycle* (2002), Bernd Kremling's *Drumming Hands Orchestra* (2003), and David N. Baker's *Concertino for Cellular Phones and Symphony Orchestra* (2006).[26] In the latter case the audience was asked to participate by ringing their phones at specific sections in the piece. At the premier Chicago Sinfonietta director Paul Freeman introduced the piece to the audience saying, "This is a great moment in history when we can say to you, 'Ladies and gentlemen, turn *on* your cellphones.'"[27] As audience participatory works of this nature are now quite common—and as this piece was *not* the first of its kind (a distinction that belongs to Golan Levin's et al. *Dialtones: A Telesymphony,* premiered September 2, 2001)—, the intended irony to permit mobile phones in the sanctuary of the concert hall seems quaint, but it is an important indicator of the social changes of the time and the way that mobile phones were working their way into public conscientiousness in all facets of life, including the arts. The core issue at hand is the intersection of public and private space: the disruptive cellphone ring in the middle of a concert brings a private interaction embedded within a public setting.

Golan Levin's *Dialtones*, though a concert piece like the others just mentioned, was different in that it featured an unusual technology that enabled one person to call multiple

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[26] Tobias Trier, email message to author, October 21, 2012; Sandra Swanson, "Celling out," *Information Week,* April 24, 2002, accessed January 25, 2013, http://www.informationweek.com/celling-out/6501906; "Orchestra incorporates ringtones," *Ananova,* 2005, accessed October 9, 2012, http://web.archive.org/web/20050222085508/http://www.ananova.com/news/story/sm_813801.html?menu=news.technology; Daniel Wakin, "Horns Up. Bows Ready. Cellphones On." *New York Times*, October 3, 2006, accessed October 9, 2012, http://www.nytimes.com/2006/10/03/arts/music/03cell.html.

[27] Wakin, "Horns Up. Bows Ready. Cellphones On."

phones (up to sixty) at once.[28] This permitted the ability for a performer to dial an array of phones in various ways. The piece was audience participatory in that attendees were first asked to log their telephone numbers into a database and download especially composed ringtones for the performance. Audience members were then assigned seats to allow for certain spatial affects to occur by carefully sequenced phone calls. To help the audience understand the complexity of the spatial effects, each seat was equipped with an LED light that flashed when the occupant's phone was rung. A giant mirror placed above the audience allowed participants to see the larger sweeps, and pointillist spatial effects created by various ringing tactics.

Other early works that place mobile phones into the concert paradigm demonstrate the interest of having remote performers brought into the concert setting. In the case of Giles Perring's *Exchange* pieces (2001-2003), performers located outside of the concert hall—potentially located anywhere in the world—call in at specific times, with their contributions then mixed and manipulated by Perring live onstage.[29]

Just as many mobile phone artists were looking toward the phone entering the concert hall, others were taking the concert out into town. Though flash mobs are perhaps the most common scenarios where the arts enter into the public space in a decentralized and democratized way, many works emphasizing mobility incorporate GPS technology to embed sounds via geotagging onto a virtual 'soundscape' or 'soundmap.' While Choloniewski's work may be the first to use this technology, more works have explored the same possibilities since GPS has been available in consumer hand-held devices. Examples include Annina Ruest's *Track-the-Trackers* (2003), Layla Gaye et al.'s *Sonic City* (2002-2004), Tanaka's *Malleable Mobile Music* (2004), Carter and Liu's *Location 33* (2005), Mark Shephard's *Tactical Sound*

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[28] Golan Levin, Gregory Shakar, Scott Gibbons, Yasmin Sohrawardy, Joris Gruber, Erich Semlak, Gunther Schmidl, Joerg Lehner, and Jonathan Feinberg, "Dialtones (A Telesymphony)," 2001-2002, accessed October 9, 2012, http://flong.com/projects/telesymphony/.
[29] Giles Perring, "The Exchange," accessed October 9, 2012, http://www.exchangeart.co.uk/exchange/menu/menu.htm.

Garden (2007), and Teri Reub's *Core Sample* (2007) and *Elsewhere:Anderswo* (2009).[30] These works will be discussed in more detail in Section 3.3.

As Behrendt points out, another body of mobile music work has emerged that aims to increase awareness of the infrastructure of mobile networks or the radiation created by them.[31] Elsenaar and Stolk's *BuBL SPACE* (2003), Griffiths's *Telenono* (2004), and Bartholl's *Silver Cell* (2004) focus on deliberately jamming network signals, either shielding one from radiation or highlighting the lack of noise created in the act of disrupting connectivity. Other works allow participants to hear network activity, or as Behrendt calls it, "listening to the invisible."[32] Haque's *Sky Ear* (2004) and Kato's *2.4GHz Scape* (2006) both sonify electromagnetic frequencies from cellular networks. In *Sky Ear* participants call in to a cluster of phones that are embedded within a lattice of weather balloons. One can listen in on what the current electromagnetic frequencies sound like at the location and elevation of the balloon cloud at that moment.[33] *2.4GHz Scape* is likewise intended to help increase awareness of the sea of invisible radio signals permeating our daily life. Audience participants are invited to create signal interference by making phone calls.[34]

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[30] Annina Ruest, "Track-the-Trackers: Mapping and Sonifying Urban Landscapes," 2003, accessed October 9, 2012, http://www.anninaruest.com/a/trackers/index.html; Layla Gaye et al., "Sonic City: The Urban Environment as a Musical Interface," in *Proceedings of the 2003 Conference on New Interfaces for Musical Expression (NIME-03)*, Montreal, Canada: 109-115; Atau Tanaka, "Mobile Music-making," in *Proceedings of the 2004 Conference on New Interfaces for Musical Expression (NIME04),* Hamamatsu, Japan: 154–156; William Carter and Leslie Liu, "Location33: A Mobile Musical," *Proceedings of the 2005 International Conference on New Interfaces for Musical Expression (NIME05)*, Vancouver, BC, Canada: 176-179; Mark Shepard, "Tactical Sound Garden [TSG] Toolkit," accessed December 20, 2012, http://www.tacticalsoundgarden.net/; Teri Reub, "Core Sample," October 8, 2007, accessed October 9, 2012, http://www.terirueb.net/core_sample/index.html; Teri Reub, "Elsewhere: Anderswo," November 15, 2009, accessed October 9, 2012, http://www.terirueb.net/elsewhere/.

[31] Behrendt, "Artistic Approaches to Mobile Music."

[32] Ibid.

[33] Usman Haque, "Sky Ear," September 15, 2004, accessed October 9, 2012, http://www.haque.co.uk/skyear.php.

[34] Notes on Kato's piece are found in Joy et al., "Networked Music and Sound Art Timeline," Vol. 5: 403. Kato's website link posted within the NMSAT is now defunct.

2.1.6 Mobile (Phone) Music – Smart Phone Era

Our understanding of what a mobile phone is has changed dramatically within the past decade. It is not simply a wireless device that allows for telephone communications and produces ring tones. With the advent of the smartphone, many devices and objects found in everyday life (the address book, Walkman, telephone, camera, alarm clock, calculator, video game player, flashlight, etc.) have been collapsed into one device.[35] When Steve Jobs unveiled the first iPhone January 9, 2007 at Macworld, he arguably marked the starting point of the smartphone era.[36] The iPhone not only conflated devices, but also dawned a new set of onboard sensors including accelerometers, and a multi-touch screen. Additionally, integration of GPS technology and improved access to web content has created potential for efforts such as Gaye's *Sonic City* or Choloniewski's *GPS* to be accessible to a greater number of participants. These improvements in technology coupled with the eventual establishment of a market for producing smartphone applications, commonly referred to as 'apps' (offered not just by Apple but also by competitors such as Google with the Android platform), have had significant ramifications for the art that has been produced with mobile phones. It has not only increased the options for artists using mobile phones, but it has changed the nature of the artistic objectives of the works produced. Perhaps the most significant change has been the increased legitimacy of the phone as a musical instrument. Mobile phone orchestras (patterned after laptop orchestras) have been established at Stanford University (2008) and at the University of Michigan (2009).[37] As the International Conference on New Interfaces for Musical Expression (NIME) has grown so have

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[35] For the purposes of this dissertation, I define a smartphone as a wireless telephone that also has internet capabilities, Bluetooth and GPS integration, a suite of sensors including accelerometers and a touch screen, an operating system that accommodates downloadable apps, and an accessible software development kit (SDK) that permits programmers to author apps for that device.

[36] Mathew Honan, "Apple Unveils iPhone," *Macworld*, January 9, 2007, accessed October 7, 2012, http://www.macworld.com/article/1054769/iphone.html.

[37] Stanford Mobile Phone Orchestra (MoPhO), accessed October 10, 2012, http://mopho.stanford.edu/; The Michigan Mobile Phone Ensemble, accessed October 10, 2012, http://mopho.eecs.umich.edu/.

the number of presentations on mobile phones, from one submission in 2004 to eleven in 2012. It is far too early to know whether the trend will last, whether more mobile phones orchestras will surface, or whether artistic uses of mobile phones will prove to be a stopgap solution along a path toward something else. But as will be shown in Section 3.1, mobile devices have incredible potential for musical interaction if for no other reason than their worldwide ubiquity.

2.2 Blurring roles: composer, performer, and audience

2.2.1 Introduction

In the previous section the bulk of the timeline traces approaches to mobile music with a specific focus on the composers: the ones who write the music, establish the parameters of the framework, handle the programming, or control the overall concept of what the artistic experience will be. In many cases the performers are actually the audience, and the outcomes of the works often incorporate open-ended forms, elements of chance, or deliberately uncoordinated interactions. This begs the question as to whether composer/performer/audience model is appropriate for assessing these musical frameworks. After all, if a gallery visitor initiates an automated performance by dialing a number, or if a text message will be converted into sound, then where does his/her role as audience member end and performance responsibilities begin? Can this be called a performance, or are other descriptors necessary? In the case of Levin's *Dialtones*, audience members may hold their phones as carriers of the instrument (or at least part of the instrument), but their part in the creative act is not to perform, but to play the part of steward. Part of the beauty of the mobile phone and its multifarious uses is that the division of labor can be configured in many ways. However, since I am now discussing works that invite everyday people to take part in music in non-passive ways, new roles need to be defined. To begin, I will highlight two additional roles proposed by Paul Lansky to pair with the composer-audience-performer model: the *sound giver* and the *instrument builder*. Both roles are not exclusively tied to mobile devices, but more often than

not both are intrinsic to what we call mobile music. Next, I will revisit Laurie Spiegel's concept of describing levels of participation in terms of a multi-dimensional matrix involving many non-quantifiable variables. With Lansky's and Spiegel's models ready-at-hand, we will be equipped to assess several mobile phone works that demonstrate different configurations, but all fall under the umbrella of 'audience participatory' or 'interactive' works. Previously, in Section 1.3 I investigated how authorship is evolving with interactive mobile apps that mainly cater to *individual play*. In this section I will focus on five mobile music works that emphasize *social interaction* with an eye toward exploring who is doing what: Ligna's *Wählt die Signale* (2003), Levin's et al. *Dialtones* (2001), Eacott's et al. *Intelligent Street* (2003), and Knowles and Paek's *3001: Massively Multiplayer Musical Instrument* (2007).

2.2.2 The Sound-Giver

As a default, the smartphone, like its predecessor, the iPod, is meant for personal use, for a single user. "We put our headphones on when we listen to our iPods for a reason – we want to enter the musical worlds created by songs and albums."[38] We tune out the outside world and create a little bubble of insulation. This is particularly useful where one is forced into close proximity to others in a public space, such as in a subway car (especially at rush hour). In my experience in New York, this is a frequent scene: by dawning the headphones and closing his/her eyes, one escapes into the world of sound. Equally important, one also visually signals his/her established privacy in a public space.

Now consider the portrait illustrated in the photo in Figure 2.2: two friends are sharing one pair of earbud speakers to listen to music on an iPod while on a train. One can see the portability of the iPod leveraged for a deliberately social activity: sharing. The design intentions are being circumvented by the users. If there was a better way of sharing the music, it is likely the two would be doing that, but as a matter of pragmatism, they make do with their resources,

[38] Carter and Liu, "Location33: A Mobile Musical," 176.

both leaning forward to figure out a distance that will not yank the earbud from his friend's ear.[39] This, like the isolated subway travelers, is also a common scene.

Figure 2.2. *Buds sharing earbuds*. Photo by Barry Martin. Used by permission.

In an essay "A View from the Bus: When Machines Make Music" Paul Lansky discusses the emergence of a new kind of musician: the sound-giver. The sound-giver is not a composer, nor a performer, nor just a listener. Rather, the sound-giver combines elements from the roles of all three.

> Being a sound-giver may mean simply giving a cassette to a friend, or it may mean publishing a compact disc. The sound-giver may or may not have made the sounds on the tape, it really doesn't matter. It may even mean being the sonic source for someone

[39] Today the iPod as personal musical device is often being replaced by a smartphone that functions both as mobile phone and personal musical device. It is plausible that this scene could feature a smartphone rather than an iPod. It should be noted that prior to the iPhone the iPod did not have onboard speakers, meaning that sharing had to be used with earbuds or some external speaker. Whether sharing music with earbuds or via onboard speakers, iPod or smartphone, the act of sharing music with portable digital devices is largely the same.

> else's musical explorations. Before the advent of recording the only way one could be a sound-giver was to be a performer. Today, however, most of us would have to admit that giving and receiving sounds in one way or another is the most active part of our musical social life.[40]

Lansky asserts that the development of recorded music has fundamentally changed a very old procedure for enjoying music: the composer-audience-listener paradigm.[41] In this model the composer is genius/author, the performer is genius/servant, and the listener respectfully adores both. Lansky presents these as three nodes within a network, and then explains the context in which the nodes of this network communicate and interact (mainly concerts), and that the degrees of passiveness and activeness of the individual nodes are relatively fixed. He also asserts that this model tends to discourage evolution and promotes institutional stability.

Brian Eno likewise discusses the way art has been transferred, and likewise outlines the historical shifts between old models and new, but Eno framed the discussion as a pre- and post-Darwinian evolution of how we view the transmission of art and ideas.

> According to Eno, pre-Darwin imperial Britain looked something like this: There was God, then came the king, gentlemen, horses, women and last the French. This represents a classic pyramid-shaped model of organization and enlightenment. Information flows in one direction where intelligence is at the top and gets diluted on the way down to the bottom. An example of this model is the classical idea of the musical genius as impersonated in Giotto, Beethoven or Bach at the top and "bad" art like folk and pop music at the bottom.[42]

In the synopsis of Eno's presentation by Sasha Pohflepp, Eno goes on to explain bottom-up design and linked that to Darwin's thoughts on ecology, how everything is connected, and how "you can never do *one thing* in nature."[43] All of us as humans form a network of nodes with no

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[40] Lansky, "A View from the Bus," 107. Though cassettes and compact discs are referenced here, the changes in medium sharing mp3 files or links on the internet are inconsequential.
[41] Lansky, "A View from the Bus," 103.
[42] Sasha Pohflepp, "Before and After Darwin," *We Make Money Not Art*, January 13, 2007, accessed October 11, 2012, http://we-make-money-not-art.com/archives/2007/01/before-and-afte.php#.UHbMh6TyaQY.
[43] Pohflepp, "Before and After Darwin."

top or no bottom, like a rhizome.[44] The similarity of metaphorical language used between Lansky and Eno is striking: both refer to nodes and networks to make sense of the changes taking place in the arts.

I believe that the top-down model Eno cites and Lansky's composer/audience/listener paradigm are both fundamentally rhetorical in nature, meaning that communication more or less goes in one direction, as a sermon does in church. In contrast, the sound-giver operates without dependence on institutions and transmits music mainly from person to person. Lansky states, "…To take these [new nodes] seriously is to fundamentally reassess the situation and broaden the realm in which this music lives."[45] He continues:

> At first blush this may seem like a weak concept, but if you accept it [the sound-giver concept] in the network the consequences are very interesting. In adding this node I am making what I consider to be a radical assessment of the social effects of technology. The attributes of skill and genius are no longer the sole prerequisites for inclusion in the network as a sound generating node, as we are used to thinking in the case of composer and performer.[46]

Lansky manages to describe a current musical-social practice while also stipulating that it is not necessarily an outgrowth of a previous model. It is an entirely separate thing, made possible through recording technology and made especially easy through digital technologies. By leaving the performer as a node in the network intact, the ideology and traditions associated with performance, discipline, craft and virtuosity also remain intact. Meanwhile, the sound-giver enjoys some of the benefits traditionally reserved for the composer or performer without having to attain virtuosity.

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[44] In *A Thousand Plateaus* Deleuze & Guatarri (1988) used the rhizome as a metaphor to describe the flatness and fragmentary nature of information networks. Schroeder (2009) and Coyne (2001) note that Deleuze & Guatarri focus disconnection and fragmentation—not unity and idealized connectivity—in the evolution of ideas. Giles Deleuze and Félix Guatarri, *A Thousand Plateaus: Capitalism and schizophrenia*, (Minneapolis, MN: University of Minnesota Press, 1988); Schroeder, "Dramaturgy as a Model," 308-81; Richard Coyne, *Technoromanticism: Digital narrative, holism and the romance of the real*, (Cambridge: MIT Press, 2001)

[45] Lansky, "A View from the Bus," 107.

[46] Ibid.

2.2.3 The Instrument Builder

Although instrument building is an ancient practice, creating instruments from computer hardware and software is by comparison a very new and very different endeavor. Thus Lansky's *instrument-builder* is not a reference to the grander tradition of instrument design, but limited to digital music instruments (DMIs). It is the arbitrary nature of its construction that sets a DMI apart from traditional instruments. The plasticity of configurations of DMIs was discussed earlier in 1.1, but here I wish to draw attention to the impact of the instrument-building process on the composer and the resulting composition. Chris Brown notes,

> In the 1970s there was an expectation that technology would liberate the composer from the practical limitations of acoustic instruments and human performers. What wasn't perhaps foreseen was that by making the relationship of sound to creator an arbitrary one, music is stripped of its context... Thus, instead of freeing composers from instruments, composers have become more involved in the design and implementation of instruments.[47]

Consequently, according to Lansky, "instrument design and construction now become a form of musical composition. The vision of the instrument-builder can be idiosyncratic, and even compositional. Playing someone else's instruments becomes a form of playing someone else's composition."[48] For the instrument-builder, a digital musical instrument may be crafted as part of an isolated compositional work or small set of works, and "may have a history no longer than the builder's most recent project."[49] This is especially true with many mobile phone artworks where the 'instrument' is synonymous with the piece. Lansky concludes,

> Musical systems now become ways to listen, perform, and compose through the mind of another. Or perhaps of many others. In some ways an instrument builder becomes a subclass of composer. In other ways composer becomes a subclass of instrument builder.

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[47] Chris Brown, John Bischoff, and Tim Perkis, "Bringing Digital Music to Life," *Computer Music Journal* 20, no. 2 (1996): 28.
[48] Lansky, "A View from the Bus," 108.
[49] Ibid.

> Whatever the formalization, however, it is clear that the number of ways in which the nodes are now capable of interacting has increased greatly.[50]

2.2.4 Spiegel's Multi-dimensional Matrix

Whereas Lansky uses a network of nodes as fixed and well-defined points to describe the social roles within modern music-making interactions, Laurie Spiegel proposes a model using a multi-dimensional space.[51] She calls this a multi-dimensional representation of interactive musical generation. Within this space, methods and systems (not just players) are localized as positions along various axes (similar to XYZ coordinates in 3D space, but with more than three axes). Some axes involve non-quantifiable variables, in which case the positions of these methods "would also best be represented as vectors of relative length (ranges along each continuum) rather than as point locations on the axes."[52] Here are the axes:

1. Degree of human participation (completely passive listening versus total creative responsibility);
2. Amount of physical coordination, practice, and/or prior musical knowledge required for human interaction;
3. Number of variables manipulable in real time;
4. Number of variables manipulable by the user (not the coder) prior to real-time output ("configurability");
5. Amount of time typically needed to learn to use a system;
6. Balance of task allocation (human versus computer) in decision making in the compositional realms of pitch, timbre, articulation, macrostructure, etc., and/or in labor-intensive tasks such as notation or transcription;
7. Extensiveness of software-encoded representation of musical knowledge (materials, structures, procedures);
8. Predictability and repeatability (versus randomness from the user's viewpoint) of musical result from a specific repeatable human interaction;
9. Inherent potential for variety (output as variations of a recognizable piece or style, versus source not being recognizable by listeners);
10. Ratio of user's non-real-time preparation time to real-time musical output;

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[50] Ibid. It is noteworthy that Lansky is mixing the notion of a non-hierarchical network of nodes with a hierarchical structure of classes and subclasses. It suggests that we might use either model for representation, depending on the nature of the composition or artistic work in question.

[51] Rolnick and Spiegel, "Performing with Active Instruments," 5-6.

[52] Rolnick and Spiegel, "Performing with Active Instruments," 6.

11. Degree of parallelization of human participation;
12. Degree of parallelization of automated processing;
13. Number of discrete non-intercommunicative stages of sequential processing (e.g. composer-performer-listener or coder-user-listener versus integrated development and use by single person or small community);
14. Degree of multi-directionality of information flow;
15. Degree of parallelization of information flow;
16. Openness versus finiteness of form, duration and logic system.

These factors will form a valuable rubric for assessing the design and outcomes of *4Quarters* as it pertains to interactivity, and will be addressed in Chapter 4. For our purposes here, I will use these parameters to provide more detail about how the composer, performer, and audience (or sound-giver and instrument-builder) interact in a sampling of 'audience participatory' mobile music works.

2.2.5 Audience Participatory Mobile Music

Wälht die Signale – Radioknozert für 144 Handys

This work by artist collective Ligna was a twelve-hour radio performance with countless participants, taking place April 26th-27th 2003 in Hamburg.[53] Ligna served as the instrument builder, creating a 12 x 12 grid of 144 mobile phones mounted on a wall at the contemporary art museum Galerie der Gegenwart. Jens Röhm composed ringtones for each phone specifically for the event. The ringtones ranged from single sustained tones to tone clusters and chords with various rhythmic patterns. The radio and internet were components of the instrument as well; all sounds were broadcast live online and over the radio via several German FM stations. As the sound was the result of incoming phone calls, the radio and internet were not just broadcast media, but also a means for performers to make choices. Phone numbers were distributed by flyers but also posted on the website, with the grid of phones being displayed as an "abstract field of light dots. So during the concert one could see which phone was ringing and which one

[53] Ligna, "Dial the signals! Radio Concert for 144 Mobile Phones," posted July, 2009, accessed October 12, 2012, http://ligna.blogspot.com/2009/07/dial-signals-radio-concert-for-144.html.

was silent. This enabled participants to choose consciously which sound they wanted to add to the sounds that they already heard."[54]

In looking to Lansky's model of nodes, the participant (let's assume participation means placing a phone call) is perhaps best described as a sound-giver: one who enjoys the benefits of composition, performance, and listening all at once, albeit on a low level. The amount of physical coordination, practice, and/or prior musical knowledge required for human interaction (Spiegel's second axis) is low. At the same time, the sound-giver has a fair amount of responsibility to control the performance, and is doing so in a way in which it will be broadcast to an unknown number of listeners. The caller can influence the sound and add an element of purposeful organization to the performance (i.e. composition), but there is unpredictability from moment to moment, since no caller could know in advance whether other callers would join. As the performance went through the night, the texture became sparse or silent as fewer callers were staying up to dial in. In Ligna's synopsis, they emphasize the concept of collective composition:

> The composition couldn't be controlled by anybody, but everybody was responsible for its development in the way he or she responded to the sound the others made with an own contribution. Every response changed the association in an unpredictable way. An answer without a question. Thus to compose did not mean to communicate, but to enjoy this impossible collective responsibility – to enjoy dissemination.[55]

In looking at the number of variables manipulable by the user in real-time (Spiegel's third axis), there are 144 options, but notably, one cannot configure the variables prior to real-time output. The process in decision-making is therefore done on-the-fly, which also has a significant bearing on the compositional process and the nature of the musical experience beyond the perceived randomness of the performance due to other callers dialing in. In aggregate we might call this experience more of a musical activity of discovery rather than an execution of a predetermined composition.

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[54] Ibid.
[55] Ibid.

Dialtones: A Telesymphony

This piece has striking similarities to *Wählt die Signale* in its technical structure, but is fused with a predetermined composition. Like Ligna, Golan Levin and his team served as instrument builders, creating a complex web of linked technologies in order to realize the performance.[56] They similarly designed over one hundred ringtones for each performance, with the phones being arranged in grid-like fashion. A distinct difference here is the scale of the grid, and the scale of the performance space. Instead of the phones being mounted close together on a wall within a gallery space, the grid is mapped onto the seating area of a concert hall, and the phones belong to the audience members. When arriving to the concert, each audience member was asked to register his/her mobile phone into a database (both calling number and model number) at kiosks in the lobby. In the process a participant received a specific seat assignment via text message and a new ringtone was downloaded onto the phone. (In some cases incompatible phones could not download the ringtones, adding an element of chance to the system and altering the realization of the composition.) With everyone situated, the format of the performance fell inline with the composer-performer-audience paradigm. Though the instrument was spatially distributed and dependent on what the audience brought in their pockets, Levin's team served as the composers of a fairly fixed score, and executed the performance (roughly thirty minutes in duration) by dialing the phone numbers in the audience. The audience, by virtue of lending their phones and going through the process of downloading customized ringtones, played an indispensable role in the realization of the performance, but did not make performance decisions other than whether to sit dutifully in the assigned seat. Still, by holding a part of the instrument in their hands, and by being spatially immersed in the presence

[56] Golan Levin, "Interview for *Aculab Quarterly*," July 2002, accessed October 13, 2012, http://flong.com/texts/interviews/interview_aculab/. This interview outlines the complexity of the undertaking. The technical realization is also outlined in detail elsewhere on Levin's site: http://www.flong.com/storage/experience/telesymphony/index.html.

of the instrument, the experience of the audience member generated a level of intimacy and sense of participation that far exceeds most traditional concert settings.

Intelligent Street

Instead of taking place in a gallery or concert hall, this piece by John Eacott et al. (2004) was a set of identical installations situated in two cities, Westminster, UK and Piteå, Sweden.[57] The main premise of *Intelligent Street* is to allow pedestrians to control the music playing in a public space via SMS text messages. A set of various commands, when sent to a posted phone number, are displayed visually as a video projection indicating a portion of the dialer's phone number (protecting anonymity, but still providing visual confirmation of a received command to the participant). The command is also cued into a buffer and affects various parameters of the musical output. Again, we see the instrument builders (in this case a team of programmers and musicians) providing a musical space for everyday and ongoing interaction. Specialists handle the composition and formatting of the music within the instrument, but the tracks are written specifically to be manipulated by anyone who chooses to participate. The technology is a bridge between one level of pre-composition—one that requires a knowledge of sequencing software, extensive musical training, a significant time investment, etc.—and a second level of real-time composition on the part of the pedestrian—one that requires a knowledge of text messaging, but minimal musical training, and a relatively small time investment to learn the commands and become acclimated with the system. Participants also had the option of listening in on the activities of the sister installation by wearing headphones (in this sense the participant would be strictly an audience member).

Like *Wählt die Signale*, *Intelligent Street* gives the SMS sender a more immediate control to manipulate sound, though instead of encountering a set of 144 phone numbers with

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[57] Henrik Lörstad, Mark d'Inverno, and John Eacott, "The Intelligent Street: responsive sound environments for social interaction," *Proceedings of the 2004 ACM SIGCHI International Conference on Advances in computer entertainment technology*, Singapore, 155-162.

corresponding ringtones, here the format is closely related to a digital audio workstation. *Intelligent Street* allows one to mute or unmute multiple tracks, change the tempo, apply affects to the total sound, or switch genres. Because there is no fixed time for performance, this experience is also similar to interacting with a jukebox, only the tracks, though categorized in familiar genres (funk, hip hop, trance, tango, etc.), are not popular tunes that can only be played back one track at a time.

3001: Massively Multiplayer Musical Instrument

At NIME 2007, New York University graduate students Joshua Knowles and Joo Youn Paek presented this work at Southpaw, a club in Brooklyn.[58] Instead of using SMS messages to send commands that changed musical parameters, this piece relied on callers within the space dialing into a system that mapped their keypresses onto a video projected avatar. The avatar takes shape as a paddle attached to a plant-like stalk, and one controls the tilt and position of the paddle via DTMF keypresses, which are then sent to a server. Sound is produced when bouncing balls fall onto the paddles (see Figure 2.3). Depending on the position of the paddle and the color of the ball, the timbre of the sound will change. The performance is formatted as a twenty-minute long game, with the basic objective to try and keep the falling balls up in the air as long as possible.[59] As the group of participants collectively reaches certain point totals, they move on to new levels with parametric changes in visual display and musical content, plus added difficulty and obstacles in keeping the balls in the air. The intention in using a game-like format is to build a narrative structure where participants become emotionally invested in the outcome.

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[58] See "3001: Collaborative Musical Gameplay," accessed October 13, 2012, http://www.auscillate.com/mmmi/.

[59] A rough video documentation of the NIME performance and the instructions given by Knowles can be viewed at "PhonePlay: Big screen games you can play using any phone," accessed October 13, 2012, http://gophoneplay.com/.

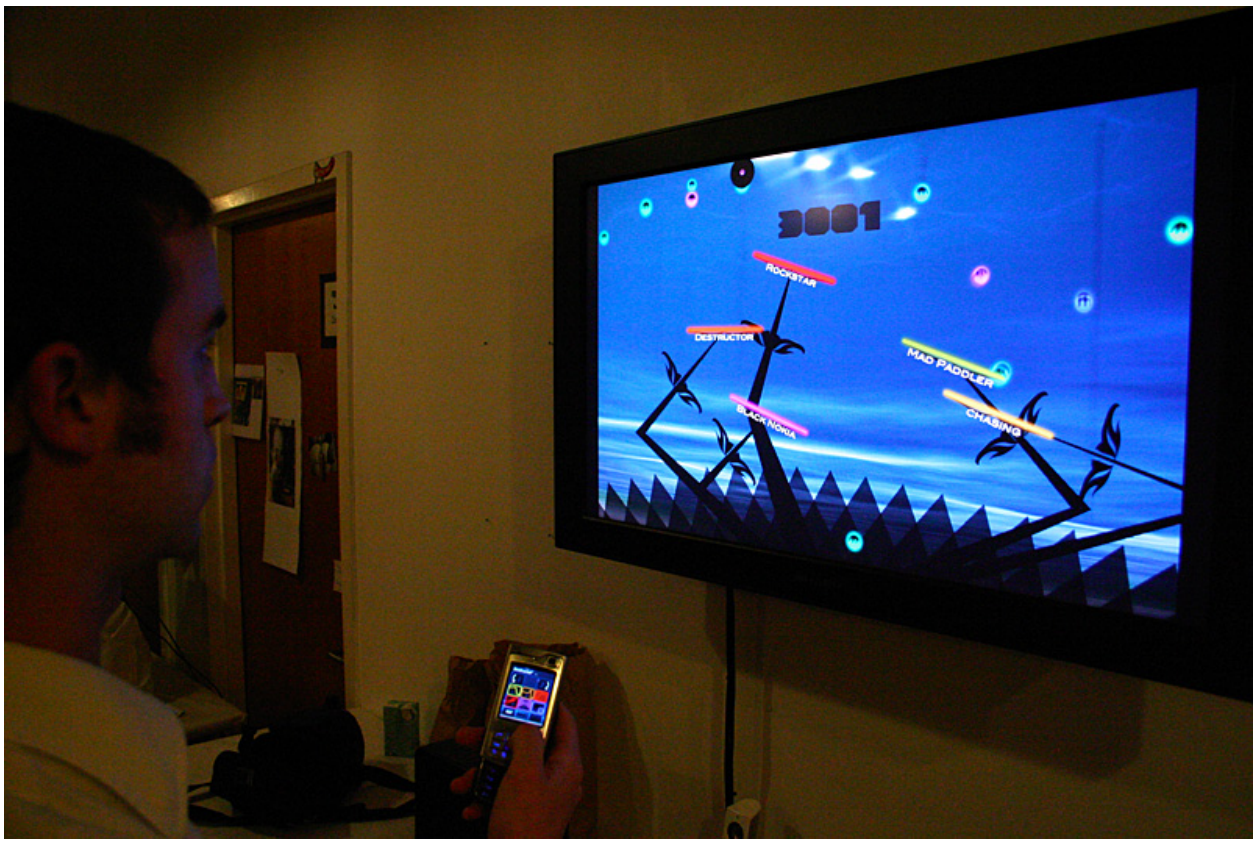

Figure 2.3. *3001: Collaborative Musical Gameplay*. Photo by Josh Knowles. Used by permission.

Like the pieces illustrated before, there is an instrument builder who presents both an instrument and compositional scheme to a group of users for a collaborative musical performance. Knowles and Paek are the specialists and receive the greater glory as artists, yet the other participants are comprised of active players (though sound-givers is again perhaps a more apt description, due to the low commitment of time and requirement of skill) and passive observers (audience). Similar to other mobile phone works, the players are exposed to the interface for the first time at the performance, then they spend a brief amount of time becoming acclimated, and they then help (in a small way) to shape a collective musical effort.

In reference to Spiegel's axes, users do not directly shape the harmonic framework of the piece, which essentially adheres to a pan-diatonic tonal scheme with various key changes between levels. The greatest influence one has on the musical outcome is to decide whether to

try and make a sound occur by bouncing a ball or to let the ball fall, which creates no sound. As a team then, depending on the rate the balls are bouncing (which is algorithmically determined by the computer), the sound can get more sparse if everyone decides *not* to follow the objective of creating as much sound as possible. Alternately, a cooperative effort to keep balls ricocheting from one paddle to the next can create a denser sonic texture with more attacks. Again, the cooperative effort is ephemeral and perhaps only a shallow form of interaction, but this effort is viewed as an upgrade over the traditional concert experience from the audience perspective.

2.2.6 Conclusions

In reviewing these works, it is clear that there has been great interest in engaging the audience beyond passive listening, and technology placed in the hands of users seems like an effective way to do so. Though at first there has been a certain novelty in moving from having *no* control over a musical experience–fixed performances in the concert hall, Muzak in public places—to *some* control, it has become apparent to many composers that a greater sense of depth is necessary to engage the 'interactive audience.' Despite the promise of new levels of engagement, the musical content is often times not a primary matter of concern, but an afterthought compared to technical configurations and their accompanying obstacles. In the next two sections I will investigate gaming models as formats for musical organization in interactive works, and the increased trend among network music scholars to focus on dramaturgy and the formation of narratives.

2.3 Gaming and non-linear music

2.3.1 Introduction

Many mobile phone artworks are not simply self-contained compositions. In most cases, a mobile phone artwork is best described as a collective instrument or as a musical architecture *through which* participants develop relationships through musical dialog. Frequently, real-time

improvisation plays a significant role in these scenarios. For audience participatory works, the composer or instrument-builder must find a balance between conflicting interests. On the one hand, the audience must be able to have an impact on the overall outcome of the piece. Their play must be meaningful. Ideally, the structure will provide participants enough control options for the participants to become emotionally invested in the outcome. On the other hand, as with any work involving chance, a composer might want to take measures to ensure that the overall outcome of the piece is artistically compelling.[60] For many composers of participative works (including mobile-based works), game theory and gaming formats have provided viable models to help reconcile elements of chance with predetermined structures. In this section I will examine musical scenarios that both use gaming components and situate the audience in roles that help determine the outcome of the piece.[61] Of particular interest is how 'meaningful play' is generated through narrative structures, goals, rules, and non-linear pathways. This exploration directly informs the design of *4Quarters* as a collaborative instrument.

2.3.2 Meaningful play

As has been explained earlier in Section 1.2, the democratization of musical software tools has created a climate that allows for everyday people to engage in music production without a disciplined musical training or knowledge of theory or notation. In a rising amateur

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[60] Christopher Dobrian, "Aesthetic Considerations in the Use of 'Virtual' Music Instruments," in *Journal SEAMUS* (2003), available on Dobrian's personal website, accessed March 1, 2013, http://music.arts.uci.edu/dobrian/CHI2001paper.pdf.

[61] For the reader interested in a more thorough exploration of game structures embedded within compositional paradigms (not visa versa), see Mark Havryliv, "Playing with Audio: The Relationship Between Music and Games," MCA-Res. Thesis, University of Wollongong, 2005. David Kim-Boyle (2008) links composers working with networks to an earlier generation of composers interested in open-form, including Brown (1965), Brün (2004), Wolff (1987), Pousseur (in Dack, 2004), Stockhausen (1959), "as well as the improvisatory work of groups such as AMM, Musica Electronica Viva and artists associated with the Fluxus School who directly situated the audience in performative roles." Due to the limited scope of this section, I will limit the discussion only to key works that have had a significant impact on the conceptual design of *4Quarters*. David Kim-Boyle, "Network Musics - Play, Engagement and the Democratization of Performance," in *Proceedings of the 2008 Conference on New Interfaces for Musical Expression (NIME 2008)*, Genova, Italy, 2008, 3-8.

culture, people frequently use these tools with no thought of financial reward, but only for the fun of it. Digital audio workstations (DAWs) such as Reaktor, Ableton Live, and Garageband as well as interactive mobile apps such as RjDj, MadPad, and Ocarina are some examples. These tools take on cultural significance because they change the relationship a user has with recorded media from one-way (passive consumption) to two-way communication. Video games have done the same thing with television. Salen and Zimmerman (2004) explain this shift by highlighting *Pong*, the first commercially successful video game:

> Pong and the games of its time did something revolutionary. They turned the one-way interactivity of the television on its head, transforming viewers into players, permitting them not just to watch a media image, but to *play* with it. This two-way electronic communication engaged players in hours of meaningful interaction, achieved through the design of a white ball bouncing back and forth on a simple black screen. Although Pong was the product of technical innovation and a unique economic vision, it was also an act of *game design*.[62]

Here I wish to draw attention to two things: first, the concept of 'meaningful interaction' through play, and second, that this is brought about through game design. The implication is that the interaction with television becomes more meaningful as a viewer becomes a player.[63] As a player within a game there is more to do, more emotional investment, more tasks to perform, and most importantly, a personal influence on what is happening onscreen. The game is fun, simple, and there is a goal motivating the players to invest in performing well. Salen and Zimmerman call this heightened activity 'meaningful play.'

> *Meaningful play* occurs when the relationships between actions and outcomes in a game are both *discernable* and *integrated* into the larger context of the game. Creating meaningful play is the goal of successful game design.[64]

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[62] Katie Salen and Eric Zimmerman, *Rules of Play* (Cambridge, Massachusetts: MIT Press, 2004), xiv.
[63] This idea can certainly be disputed, with good reason: seeing local news on TV of an impending hurricane could be far more meaningful than playing a video game.
[64] Salen and Zimmerman, *Rules of Play,* 34.

This quote might also be reasonably applied to participative mobile phone works. The concern with creating a discernable correlation between actions and outcomes is largely an interface issue, while integrated connections pertain to formal design.

> Whereas discernibility of game events tells players *what* happened *(I hit the monster)*, integration lets players know *how* it will affect the rest of the game *(if I keep on hitting the monster I will kill it. If I kill enough monsters, I'll gain a level.)*. Every action a player takes is woven into the larger fabric of the overall game experience: this is how the play of a game becomes truly meaningful.[65]

This statement demonstrates the importance of focusing on how a game structure—and likewise a network structure in a participative music work—conditions the behavior of the player involved. If discernibility or integration is not effectively established, it is less likely that the structure will sustain interest.

To examine how structures can foster discernibility and integration, I would like to compare three different participative scenarios that each use gaming elements: Jason Freeman's *Glimmer* (2004), Joshua Knowles and Joo Youn Paek's *3001: Massively Multiplayer Musical Instrument* (2007), and video games *Rock Band* (2007) and *Guitar Hero* (2005).[66] Each take place in different spaces, take place over different amounts of time, and allocate differing degrees of responsibility to players. Though *3001* is the only work of the three examples that uses mobile phones, the other two examples are relevant as participative experiences. Since the transportability of mobile phones permits their use in either living rooms or concert halls, a comparison of video games and audience participatory concert pieces is justifiable.

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[65] Ibid., 35.
[66] The format of Rock Band and Guitar Hero is generally the same, so I will use both games interchangeably here.

2.3.3 Discernibility and Integration – Three Examples

Glimmer

Jason Freeman's *Glimmer* is a large-scale audience participatory work for chamber orchestra and 600 audience members.[67] Freeman describes it as a work of software art, privileging "process over product, engagement over utility."[68] Freeman also responded to a directive from the American Composers Orchestra by making the piece fun. The experience is designed so that users with no specialized musical or technical training can feel at ease to participate, making a truly collectively created piece. Unlike several other works within the tradition where the audience is tasked with producing sounds, here the audience instead affects the music played by the orchestra.[69] Users are provided with light sticks, and the motion of the lights are captured and tracked via video cameras positioned throughout the concert hall. The incoming data is then aggregated in real-time and used to inform onstage performers what to play.

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[67] Since its premiere with the American Composers Orchestra at Zankel Hall in New York City, a second version has been created for a 16-player string orchestra and 200 audience members. Since my exposure to this piece was the first iteration, I will refer only to the premiere performance here. See Jason Freeman, "Glimmer (2004) for Chamber Orchestra and Audience," accessed November 1, 2012, http://distributedmusic.gatech.edu/jason/music/glimmer/.

[68] Jason Freeman, "Glimmer for Chamber Orchestra and Audience," dissertation, Columbia University, 2005: 19, http://distributedmusic.gatech.edu/jason/publications/pdf_files_of_publications/doctoral_dissertation.pdf.

[69] Jean Hasse's *Moths* (1986) has no performers onstage, but instead instructs the audience to whistle. In a massive outdoor musical happening entitled *La symphonie du millénaire* (2000), 2000 audience members ring handheld bells at specified moments. This is similar to David N. Baker's inclusion of the audience in *Concertino for Cellular Phones and Symphony Orchestra* (2006), where mobile phones are to be rung at specific points within a fixed score. For a more thorough explanation of large audience participation, see Jason Freeman, "Large Audience Participation, Technology, and Orchestral Performance," in *Proceedings of the International Computer Music Conference* (ICMC), Barcelona, 2005. Another resource is Jieun Oh and Ge Wang, "Audience-Participation Techniques Based on Social Mobile Computing," *Proceedings of the International Computer Music Conference (ICMC)*, Huddersfield, UK, 2011. Jean Hasse, *Moths*, Visible Music, Euclid, OH, 1986; Marc Chénard, "The Millenium Symphony: A Work for the Beginning of Time; Part I: The Musical Challenge," *La Scena Musicale* 5, no. 8 (2000); Wakin, "Horns Up. Bows Ready. Cellphones On."

Discernibility and integration are both taken into account in the design of the performance. Because of the discrepancy between user input and sonic output, it is critical that the audience knows what they are doing and how it affects the orchestra. In order to accomplish this, the audience is divided into seven teams, with the team's collective efforts determining what a corresponding group of players within a chamber orchestra should play (the range of parameters includes pitch, articulation, and dynamic level). Performers receive this information via colored lights resting on their music stands, allowing the audience to see when a new note is to be played. An element of competition is introduced to provide incentives for the audience to continually move their light sticks. If there is too little variety in their activity, a group's avatar is instructed to play quieter, or even told to be silent. The more active teams generate louder sounds, and a video screen projection provides a ranking system showing which teams are leading at any given moment within the performance. The music is deliberately sparse and slow to unfold so that audience members can hear their results. Each group of performers has a limited range of pitch options, playing from a pitch set of four adjacent notes.[70]

In spite of the effort to provide clear pathways for helping audience members discern how their actions affect the music (i.e. I hit the monster), a review of the premiere indicates that there may have been confusion.

> Mr. Freeman said the lights would respond the most inventively to the most interesting light patterns, which prompted one woman to ask the obvious question: "How do we be interesting?" Through variety, Mr. Freeman said, by avoiding the pitfall of all-on or all-off patterns.[71]

In a subsequent interview, Freeman also recognized the lack of discernibility that some participants experienced.

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[70] This constraint to limit pitch choices was not only influenced by a desire to create transparency with the audience, but also influenced by limited rehearsal time. Freeman, "Glimmer for Chamber Orchestra and Audience," 22-24.

[71] Anthony Tommasini, "With Lights in Hand, Audience Becomes Conductor," *New York Times,* January 22, 2005, accessed November 1, 2012, http://www.nytimes.com/2005/01/22/arts/music/22zank.html?_r=0.

> There were some problems, though, with the interactive design, and because of them, many audience members felt they had little influence over the music, and the video analysis data corroborated them. This was not a technical problem. It was a design problem.[72]

This led to revisions for a second performance that took place in Jerusalem, with 200 audience members situated in the round, fewer performers, and a new motion-tracking algorithm.

3001: Massively Multiplayer Musical Instrument

Like *Glimmer*, Joshua Knowles and Joo Youn Paek's work was also premiered in the New York City area as part of the NIME 2007. The scale of the performance was not nearly as large, taking place at a Southpaw, a club venue in Brooklyn. Between ten and fifteen players participated with their cellphones by dialing into a phone number displayed on a video projection. As explained in Section 2.2, each player was in charge of moving a plant-like stock with a paddle placed at its end, like a flower bud. The objective is to move the stock and adjust the angle of the paddle to prevent balls falling from above from landing on the ground. Once connected, discernibility is managed in several ways. First, the last five digits of a player's phone number are displayed onscreen underneath the player's corresponding paddle, allowing the person to recognize which stock belonged to him/her. (This did not however inform the player who the other players were; interaction was clear from player to screen, but not from person to person.) Second, verbal instructions prior to the performance provided players with information about which cellphone buttons corresponded to moving the stock and paddle angle. Third, the paddle could change colors depending on user keypresses, with each color representing a pre-set sound sample. Fourth, the pitch of the sample was controlled by the player's position of the paddle on the screen (high notes up top, low notes at the bottom). At the

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[72] Helen Thorington and Jason Freeman, "Interview: Jason Freeman," *Networked_Music_Review*, March 11, 2005, accessed November 1, 2012, http://turbulence.org/networked_music_review/2007/03/11/interview-jason-freeman/.

beginning of the piece the bouncing balls drop at a slow rate to allow players to learn these pitch relationships and acclimate to the interface.

The piece is thoroughly influenced by gameplay, with incentives provided to stimulate participation. Part of the appeal for this scenario resides in the novelty factor of transforming one's phone—keep in mind at the time few people had smartphones—into a game controller. When initially playing, one wants to make sounds simply to confirm one's connection to the system. Continued and improved play is incentivized through a point system. Each successful bounce not only makes a sound, but also generates a point total. With each successive bounce, the point total for that ball increases.[73] As the audience collectively reaches point thresholds, new levels are achieved, with new sound samples, background color schemes, and increased difficulties. Although the narrative structure is simple (try to get enough points to advance), the integration is clear. It is straightforward by design, especially since there was little to no rehearsal time, and the experience is likely not to be repeated with the same set of players.

Latency was a limiting factor for discernibility in the NIME performance, "as it ran between 1/2 second and 2 seconds, depending on a variety of factors: cellular audio data encoding/decoding, Asterisk latency, wifi latency, etc."[74] In later versions, Knowles was able to do away with phone calls and solve the latency issue by placing the interface on a web page viewed in the web browser.[75]

Rock Band and *Guitar Hero*

Popular music genre games *Rock Band* and *Guitar Hero* have been tremendously success games that cultivate meaningful play. Discernibility is handled extremely well – the Bluetooth connected controllers have minimal latency in conveying user input to visual feedback, and one can perceive whether he/she is accurately hitting notes because the user hears

[73] "For the NIME show, everyone added to the same cooperative score. Later iterations kept the scores separate." Josh Knowles, email interview with author, November 2, 2012.
[74] Ibid.
[75] Ibid.

'mess up' sounds occur if timings are off. If too many missed notes occur, the track's volume can fade or disappear altogether. Additionally, a red pulsating warning will light up the player's scroll board, and the volume level of the player's track can cut out. A virtual crowd will begin to boo the performance if too many notes are missed. Alternately, as the user correctly executes sequences of triggers, various visual and aural reinforcements inform the user of his/her success. Between songs a user's performance statistics are shown indicating the percentage of correctly executed notes as well as the longest streak of consecutively played notes.

Integration is also achieved in *Rock Band* and *Guitar Hero* through a consistent and clearly defined reward system. The user progresses from level to level by gaining better performance gigs, unlocking more songs in the catalogue, and earning virtual money to buy clothes and gear for his/her avatar. In order to do so, one must perform a certain number of songs. Though there are secret codes to unlock more games right from the start, the default tour mode requires one to spend time playing through a set list ('pay your dues'), and regardless of difficulty level, performing the songs well. In other words, the incentives of the game create a space in which a player will spend a relatively long amount of time in order to obtain rewards. During that time one will become better at the game, and will likely become more invested emotionally. This is all reinforced through the basic narrative structure of the game, which draws on rock mythology and 'what it takes' to achieve rock stardom. The important outcome here is that in living rooms throughout the world, the scenario for making music becomes more than just a novelty; it becomes a legitimate performance experience.[76]

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[76] Kiri Miller states: "…Playing these games 'feels like' making music to so many players not because of some sort of false consciousness or cult of repetition, but because the affective experience of making music is so bound up with embodied performance. It's no coincidence that in English we use the same term to talk about playing games, playing music, and playing a role on the stage. Playing Guitar Hero and Rock Band is deeply theatrical; yet there is no simulation or false promise in the games' offer of musical collaboration, and no lack of felt 'reality' in the mental, social, and physical engagement with music that they engender. Player Chris Sanders put it more elegantly: 'The energy and commitment to the music is quite real, even if the instruments are not.'" Miller, "Schizophonic Performance," 424.

From a broad perspective of *Rock Band* and *Guitar Hero's* formal design, gameplay is quite linear in format. Players attempt to perform set songs, not to create their own. The player's influence on the sound—or element of chance—comes down to whether he/she performs the song faithfully. The non-linearity of the game design is situated on a fairly local level, from moment to moment. The variations in the player's timing and accuracy determine what sound file will be retrieved (one of several 'mess-up' sounds or the recording of the 'good' performance). Once the song is successfully completed, players can choose what order they play through a set of songs for a given level. One can also purchase new songs to add to the catalogue.

2.3.4 Instruments and Games

As mobile phones become more sophisticated by merging multiple types of devices into one, it has become difficult to parse the difference between mobile musical games and mobile musical instruments. This becomes problematic when one considers the cultural environment in which these games and instruments are embedded, and the accompanying expectations one brings to an interaction with either. An instrument might have the look and feel of a game but not offer any integration by way of narrative or goals. Weinberg et al. noted this problem when gathering user feedback after interacting with the iOS app ZooZBeat:

> Interestingly, another common complaint was that the application seemed "pointless", as there is no goal or finale. Familiar with games like Guitar Hero, typical consumers of such applications seem to tend toward more structured play, where their actions are guided by more than a desire to produce satisfying music.[77]

Toshio Iwai's *Electroplankton* (2005) for the handheld Nintendo DS console is another example of a musical instrument intended for playful exploration, but not as a game.[78] It too lacks a goal or finale, in spite of being played on a game controller. Although it is possible for these instruments or interactive experiences to sustain user interest for long periods of time, a

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[77] Weinberg et al., "ZooZBeat: A Gesture-Based Mobile Music Studio," 315.
[78] Toshio Iwai, *Electroplankton*, video game, Redmond, WA: Nintendo of America, 2005.

designer must face the question of whether the instrument cannot be replicated in some other way. In the case of ZooZBeat, the concept of a studio is coupled with gestural triggers. For Electroplankton, the interest lies in the visual patterns and designs that are mapped to sounds, and that the interaction can be driven by a stylus. But if after twenty minutes the sound possibilities are explored and exhausted, then it is less likely that a player will devote countless hours toward developing a mastery of the instrument. Narrative structures and goals try to promote this mastery. Rich interface and sound design can also do the same thing. In both cases, extended time working with the interface is assumed, but depending on the circumstances of a participative work, this of course may not be the case. The next section will focus on the range of forms, depth of interaction, and resulting expectations from both participants and designers.

2.4 Forms, Levels of Interaction, and Desired Outcomes

2.4.1 Introduction

When designing interactive collaborative musical experiences for novices (as is the case with *4Quarters*), the desire to make the setup scenario easy to understand is a high priority. In many participative works, this frequently comes at the expense of being able to design an upward pathway to virtuosity with the interface. The design tradeoff is a difficult balance to achieve. In catering to novices, one is faced with reducing the number of features and opportunities for creativity in order to simplify the encounter with the interface while still attempting to foster a meaningful collaborative social experience. On the other hand, if the designer desires more complex controllers to accommodate experts, this reduces the options for possible venues, extends the time investment needed to learn to play, and likely reduces the number of participants. Here I will explore the design issues inherent in configuring multiplayer musical experiences, particularly for novice players.

2.4.2 Balancing Accessibility and Expressivity

Ideally a collaborative music system will be easy to learn, yet also permit a wide variety of expressive options. In principle, the goal would be to facilitate a rewarding experience within a short period of time while also accommodating a player interested in mastering the instrument through extended practice. In early participative works for mobile phones, the technology was a limiting factor for permitting expressivity, so accessibility was favored over musical capability. For many composers/instrument-builders who work with mobile phones, the appeal to use the devices over other controller options is a consequence of their familiarity as interfaces and their ubiquity. Their ability to serve as gateways to making music, especially for non-expert musicians, remains an attractive motivating factor. Brucker-Cohen et al.'s *SimpleTEXT* (2003) invites audience participation through SMS text messages.[79] Ligna's *Wählt die Signale* only required participants to choose from a range of phone numbers to dial, each of which triggered a receiving phone's ringtone to play.[80] In more recent examples Stanford Mobile Orchestra presented a concert in Fall 2010 employing mobile web browsers to afford audience input without the need of special software or pre-configured hardware. "This minimal setup from the audience's side is not only convenient, quick, and cost-effective, but it also lowers the psychological barrier to entry for participation, as the audience can use their own *personal,* familiar devices."[81]

Even as mobile phones become more sophisticated with increased computational power, storage space, sensor, software and signal processing options, other factors (time limitations, physical space, number of participants, etc.) can still necessitate simplicity. The challenge is to determine ways to establish low-level accessibility without cutting off the range of expressive options. Blaine and Fels (2003) note, "Supporting a pathway to expert performance is difficult

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[79] Jonah Brucker-Cohen, Tim Redfern, and Duncan Murphy, "SimpleTEXT: A Cell Phone Enabled Performance," 2013, accessed March 1, 2013, http://simpletext.info/.
[80] Ligna, "Dial the signals! Radio Concert for 144 Mobile Phones."
[81] Oh and Wang, "Audience-Participation Techniques," 665.

because the ease of learning is often realized by restricting the range of musical possibilities available to the player through computer-mediation."[82] If a collaborative music system is too simplistic, it runs the risk of becoming a novelty, incapable of sustaining interest. Wessel and Wright (2001) assert: "…many of the simple-to-use computer interfaces proposed for musical control seem, after even a brief period of use, to have a toy-like character and do not invite continued musical evolution."[83]

2.4.3 Scalability

Blaine and Fels (2003) state, "By their very nature, collaborative interfaces are designed for a minimum of two or more players. However, the number of players greatly influences the types of interfaces and music that is appropriate. An interface built for two people is generally quite different from one built for tens, hundreds or thousands of players."[84] By way of illustration I will compare *Glimmer* and *Rock Band/Guitar Hero*. Having 600 (and later 200) audience members in *Glimmer* versus having a maximum of seven performers in *Rock Band 3* yield tremendously different outcomes in defining roles and the allocation of performance responsibility. Returning to Laurie Spiegel's multidimensional representation of factors for interactive musical design, the first five axes listed are:

1. Degree of human participation (completely passive listening versus total creative responsibility);
2. Amount of physical coordination, practice, and/or prior musical knowledge required for human interaction;
3. Number of variables manipulable in real time;
4. Number of variables manipulable by the user (not the coder) prior to real-time output ("configurability");
5. Amount of time typically needed to learn to use a system;

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[82] Tina Blaine and Sidney Fels, "Contexts of Collaborative Musical Experiences," In *Proceedings of the 2003 Conference on New Interfaces for Musical Expression (NIME-03),* Montreal, Canada, 132.
[83] David Wessel and Matthew Wright, "Problems and Prospects for Intimate Musical Control of Computers," in *Proceedings of the CHI'01 Workshop on New Interfaces for Musical Expression (NIME-01)*, Seattle, USA, 2001, 11.
[84] Blaine and Fels, "Contexts of Collaborative Musical Experiences," 130.

A consideration of these continua in relation to these works reveals how the scale of a work affects design.

Although both works exemplify a fundamental desire on the part of the designers to include entry-level musicians in the flow of real-time music-making, the designers go about it in different ways. This divergence in approach is partly due to the constraints of space and time. *Glimmer* was not only was meant to be able to work as a one-time concert experience at a public venue, but the mode of interaction chosen was basic because there was no time available for a full-scale rehearsal.[85] This constrained the amount of time users would have to learn the system, which directly impacted interface design considerations and how many variables audience members could manipulate in real time. User input is reduced to turning a light stick on and off. As a result, there is a lower degree of creative responsibility on the part of the individual attendee, though it is not completely passive.

By comparison, *Rock Band* and *Guitar Hero* are designed for consumer use, which means that the music-making experience is likely to take place in a living room or in some private space. This changes the amount of time that one may have to practice, which in turn means that more physical coordination can be required, with more sophisticated interface controls offering more variables manipulable in real time. Although players do not have full responsibility for creative output as they essentially follow a score of a popular song (as opposed to composing their own song), Miller's (2009) findings indicate that the experience is far more involving for players than passive listening.[86] Still, the engagement is couched within the context of being a lower form of play than performing with 'real' guitars.[87]

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[85] Freeman, *Glimmer* (2005), 22-23.
[86] Miller, "Schizophonic Performance," 423-425.
[87] Ibid., 419.

2.4.3 Facilitating Social Interaction

In both *Glimmer* and *Rock Band/Guitar Hero*, the reductive design does not necessarily constrict participant's ability to engage creatively in the music-making experience. Some participants essentially circumvent design limitations by adding their own 'creative touch.' Miller highlighted an emergent trend of *Rock Band/Guitar Hero* players adding their own theatrics to the performance, mimicking rock star stage antics.[88] Freeman likewise observed an unexpected social phenomenon from the performance of *Glimmer*:

> But most importantly, audience members enjoyed waving their light sticks around much more than switching them on and off, even though they knew that such activity had little effect on the music. Not only was it more fun to do, and not only was it more pleasing to watch, but it also gave them the feeling of more communication with and control over their peers. They were able to communicate a range of information to each other — if not to the computer software — through their stick's position and speed, going beyond mere onoff signals.[89]

Responding to Freeman's quote, Wang and Oh (2011) noted, "Perhaps experiencing this kind of social communication between the audience members is a byproduct of active engagement, almost even an emergent property of a successful audience-participation design paradigm."[90] Both Freeman's and Wang & Oh's comments demonstrate that design cannot fully anticipate how users will interact with a system, and that the desired outcome (heightened audience interaction) can be accomplished even if the system (the audience influencing the composition) is diminished in the process. Although the live event yielded unexpected but positive results, Blaine and Fels (2003) suggest that this is exactly what designers of collaborative musical environments should aim to do. "In a collaborative musical environment, it becomes even more imperative that the technology serves primarily as a catalyst for social interaction, rather than as the focus of the experience."[91]

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[88] Ibid., 417-18.
[89] Jason Freeman, "Large Audience Participation."
[90] Oh and Wang, "Audience-Participation Techniques," 667.
[91] Blaine and Fels, "Contexts of Collaborative Musical Experiences," 129.

2.4.4 Play and Process vs. End-Product

As designers of collaborative musical environments devote attention toward the experience of music-making (as opposed to the musical results), playful exploration becomes a central focus. The process of musical discovery and the pleasurable act of making music becomes favored over a well-crafted composition or recording. This again represents a tradeoff in artistic goals: if *anybody* can engage with musical objects or interactive systems for the purpose of exploration, and if there are a wide range of possible outcomes, then the results will be unpredictable. Chris Dobrian asks, "If the audience controls the piece, one might wonder, how can you 'guarantee' that it will still be artistically compelling?"[92] This implicitly raises a second question about what constitutes an 'artistically compelling' work. Dominic Dobson, whose work centers on playful sound exploration for non-musical participants, appealed to John Cage's aesthetic of process-oriented music:

> In *Experimental Music* in 1958, John Cage talks about the importance of play, "the purposeful purposelessness" that serves as "an affirmation of life – not an attempt to bring order out of chaos nor to suggest improvements in creation, but simply a way of waking up to the very life we're living."
>
> As we grow up the activity of play that is so important to us as children, allowing us to explore and understand the world, can become lost. This is particularly true of music in which the greater availability of recorded music has continually offered us more convenient but more passive ways in which to appreciate music.[93]

Here we see the reasoning commonly found among interactive instrument-builders to create a heightened audience experience. Generally speaking, passive listening is viewed as one limiting factor in musical engagement within an artistic experience that can be overcome by technology.[94] Dobrian puts it this way: "In the case of most earnest inventors/builders of new instruments, the design grows from the urge to 'build a better mousetrap', to overcome the limitations of traditional instruments." We might also say that the attention to interaction is

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[92] Christopher Dobrian, "Aesthetic Considerations," 4.
[93] Dominic Robson, "PLAY!: Sound Toys For the Non Musical," In *Proceedings of the CHI'01 Workshop on New Interfaces for Musical Expression (NIME-01)*, Seattle, USA, 51.
[94] Of course, passive listening is not inherently an inferior mode of musical reception, nor is the increased ability for an audience member to affect the musical outcome of a system a guarantee for artistic success.

also a manifestation of the urge to overcome the limitations of the traditional composer/audience/performer paradigm discussed in Section 2.2. Clearly the format of presentation is not a sole indicator of artistic success, even with these attempts to create an artistically compelling work through manipulating the levels of interaction for audiences.

Regardless of how one critically assesses the quality and effectiveness of a collaborative music system, instrument, or composition, the value of the work should not be based on the musical results alone. Chris Dobrian posits,

> And why should we apply traditional criteria of what constitutes a rewarding artistic experience for an audience, in this new case of audience interaction? The old model is based on the audience as passive observers of music-making. This new model proposes audience members as active participants in the music-making, interacting with intelligent control systems.[95]

Although *Glimmer* is a concert piece, for instance, the resulting performance as a fixed sound object is not where its aesthetic merit lies; the value lies in the process. Freeman's personal response to the piece reflects this attitude:

> But with this piece, I'm not interested in listening to the results of the performance as an independent musical object. It's about the experience of being a part of the performance, of having a stake in how it progresses, of working with and competing against fellow audience members to exert influence upon the piece.[96]

2.4.5 Conclusion

Ultimately, an ideal outcome would be to have an experience that is both satisfying on an interactive level during performance and as an end product. Nevertheless, this remains perhaps the greatest challenge. Freeman states:

> But could the work ever make all 600 audience members feel truly indispensable to its performance? Large-audience participatory works cannot promise instant gratification: giving each person a critical role; requiring no degree of experience, skill, or talent; and creating a unified result which satisfies everyone.[97]

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[95] Dobrian, "Aesthetic Considerations," 4.
[96] Thorington and Freeman, "Interview: Jason Freeman."
[97] Freeman, "Large Audience Participation, Technology, and Orchestral Performance."

I believe that there is no perfect solution to these problems, nor is there a one-size-fits-all approach that will guarantee an 'artistically compelling' experience for any participative system. Still, there are strategies that seem likely to work better than others, depending on the venue, size, and scale of the work.

1. If an audience member can use his/her own familiar device, there is a lower psychological barrier to entry to audience participation.
2. Mobile phones (as opposed to other controllers) work especially well for time-sensitive setups. They combine accessibility with a rich set of sensors and computational capacity.
3. Web-based interactive applications used on phones are the best options to date to offer low-latency, cross-platform access for audience participants.
4. Directed interaction with a 'master performer' is a safe tactic from a performance standpoint, but it is also a practical solution for quickly teaching how audience members should engage.
5. Stories, goals, or game structures likewise can teach audience members' roles fairly quickly.
6. Lighting and visual displays can facilitate discernibility of cause and effect. These can also easily become distracting and change the focus away from the sonic experience.
7. Leveraging social media within a musical context is yet an additional step toward building off familiar interfaces. This runs the risk of being a novelty, however, drawing attention to the augmentation of the user's typical experience with social media (i.e. Twitter is not just communication, but directs musical events, as opposed to musical event that happens to use Twitter).

This last concern about a novelty factor can be broadly applied to mobile phones in general, and if taken further, can be applied to any digital musical instrument or system that attempts to overcome the limitations of traditional instruments and performance paradigms. Mobile phones nevertheless create truly unprecedented opportunities for audience participation and communication, in part because of their mobility.

CHAPTER 3. MOBILE PHONES IN MUSIC

Introduction

In this chapter I will trace how the mobile phone has been used a musical instrument, and will explore the reasons that motivate mobile phone musical instrument development. Ubiquitous computing is a part of the equation, but improvements in hardware and accessibility of programming tools for mobile phones have been significant factors in attracting composers and engineers to turn toward mobile phones for musical experimentation.[1] I will focus on how and where mobile phone musical scenarios take place, and examine the efforts made by mobile phone music ensembles.

3.1 Mobile Phones as Instruments

3.1.1 Introduction

In this section I will trace the paths in which the mobile phone has been used as an instrument: as a 'pocket' version of extant acoustic instruments, as a standalone instrument not modeled explicitly upon acoustic instruments, and as networked instruments or controllers. I argue here that, like computers and laptops, the multiplicity of functions—both musical and non-musical—of mobile phones prevent the devices from being universally recognized as legitimate musical instruments. At the same time, the flexibility of configurations has led to diverse means for personalization and implementations in musical contexts. As a result of both of these factors, it is and will remain difficult for instrument-builders to establish culturally

[1] The term *ubiquitous computing* is now its own field of study, as inspired by Mark Weiser's vision of computing artifacts that disappear. Here I use apply this term to the widespread entrenchment of mobile phones in modern society. The total number of individual cellular subscribers topped 5 billion in 2010, more than two-thirds of the world population. Figures from UN agency International Telecommunications Union (ITU), as quoted by UN News Centre, "Robust regulation of information technology crucial for economic growth – UN," posted March 31, accessed April 1, 2011, http://www.un.org/apps/news/story.asp?NewsID=37962&Cr=technologies&Cr1; see also Vivienne Waller and Robert B. Johnston, "Making Ubiquitous Computing Available," *Communications of the ACM* 52, no. 10 (2009): 127-130.

understood metaphors and gestures associated with mobile phone music. The mobile phone as an instrument will likely remain defined by its indeterminate quality.

3.1.2 Mobile Phone Music Prior to Smartphones

Before the advent of the smartphone, most mobile music pieces tended to leverage the networking features of phones to allow users to place phone calls or SMS text messages to trigger sound events. If the phone was used as the primary sound source, the sound producing options were either limited to ringtones or to the mic and speakers designed for phone calls. In order to execute ringtone playback, the most direct way was to place a phone call to the corresponding number from another telephone. *Telephony* (2000), *MobilSymfoni* (2001), *Spring Cellphony* (2001), *Dialtones: A Telesymphony* (2001), *SIM-phone-ya (New Ring Cycle)* (2002), *Drumming Hands Orchestra* (2003), *Wählt die Signale!* (2003), and *Concertino for Cellular Phones and Symphony Orchestra* (2006) are all ringtone-based works triggered by placing phone calls.[2] A slight variation includes pieces that rely on phone calls for input, but with sonic output handled through an external system and sound source. Brucker-Cohen's *Musical/Devices* (2002) and Knowles and Paek's *3001: Massively Multiplayer Musical Instrument* (2007) are two iterations of this concept.[3] Other works incorporate the receiver of the phone, linking individual callers' audio input to a loudspeaker output; Max Neuhuas's *Public Supply* pieces (1966, 1968, 1973), Kelly Dobson's *Agoraphone* (2002), and Giles Perring's *Exchange* pieces (2001-2003) are examples.[4] Usman Haque's *Japanese Whispers* (2000) and *Sky Ear* (2004) are works that incorporate the device's microphone and receiver in tandem for

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[2] With the exception of Baker's *Concertino*, all these works are cited within Golan Levin et al., "Informal Catalogue of Mobile Phone Performances, Installations, and Artworks."
[3] See further discussion of Knowles and Paek's work in chapter 2.
[4] Although Neuhaus's *Public Supply* works precede mobile phone technology, conceptually it is the same. The change from landlines to mobile devices affected sound quality on the receiving end, but these are not significant differences. In other words, the mobility of cellular phones for pieces described here is not a crucial component of the artistic framework and design. Kelly Dobson, "AgoraPhone," (master's thesis, MIT, 2002), http://dspace.mit.edu/handle/1721.1/61129; Perring, "The Exchange."

musical purposes.[5] *SimpleTEXT* (2003) takes anonymous SMS text messages from audience members as input, then parses the messages and coordinates them to be played rhythmically with music through a speech synthesizer. Other SMS-based sound works include *Text.FM* (2002), *Intelligent Street* (2003), and *Tool for Armchair Activists* (2005).

Prior to the advent of smartphones, some artists created custom-made augmented personal digital assistants (PDAs) to leverage mobility in their artistic works. Atau Tanaka presented a system for collaborative music-making through the use of pressure sensors and accelerometers attached to PDAs.[6] Günter Geiger developed a method for porting Pure Data patches to Linux-based portable devices in order to combine real-time synthesis with touch screen input.[7] GPS-based works such as *Sonic City* by Gaye et al. (2003) and *Tactical Soundgarden Toolkit* Mark Shepard (2007) also make use of PDAs as tools for exploring urban landscapes with sound, and will be discussed in Section 3.3. Schiemer and Havryliv (2005) created *pd2j2me*, a desktop application cross-compiler that translates Pure Data patches into Java, for the purpose of eliminating the need for composers to compose for mobile phones by writing java code.[8] This project enabled Schiemer to pioneer the first synthesis-based instrumental use of mobile phones with his PocketGamelan in 2006.[9]

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[5] Usman Haque, *Japanese Whispers* (2000), last updated November 19, 2003, accessed February 11, 2013, http://www.haque.co.uk/japanesewhispers.php; Haque, "Sky Ear."
[6] Tanaka, "Mobile Music-making."
[7] Günter Geiger, "PDa: Real Time Signal Processing and Sound Generation on Handheld Devices," in *Proceedings of the International Computer Music Conference*, Singapore, 2003; Günter Geiger, "Using the Touch Screen as a Controller for Portable," in *Proceedings of the 2006 Conference on New Interfaces for Musical Expression (NIME06)*, Paris, France, 2006, 61-64.
[8] Java 2 Micro Edition (J2ME) is an application programming interface (API) designed to allow a standard Java platform for systems with minimal hardware. Greg Schiemer and Mark Havryliv, "Pocket Gamelan: a Pure Data Interface for Mobile Phones," in *Proceedings of the 2005 International Conference of New Interfaces for Musical Expression (NIME05)*, Vancouver, Canada, 2005, 156-59.
[9] Greg Schiemer and Mark Havryliv, "Pocket Gamelan: Tuneable Trajectories for Flying Sources in Mandala 3 and Mandala 4," in *Proceedings of the 2006 International Conference of New Interfaces for Musical Expression (NIME06)*, Paris, France, 2006, 37-42.

3.1.3 Smartphone as Standalone Musical Instrument

As mobile device technologies have matured and smartphones have become prevalent, composers have had more available options for hardware and software configuration. In 2009 Georg Essl and Michael Rohs presented a detailed summary of the technical capabilities and limitations of mobile handheld devices.[10] This approach was deemed important from a conceptual standpoint, "in the same sense that a good composer of orchestral music has to know the capabilities and limitations of orchestral instruments."[11] Essl and Roh's work provides the best summary to date of the range of possibilities for an instrumental use of mobile phones. In brief, the different kinds of musical interactions leveraging onboard sensors include optical tracking of markers and grids using the phone's camera, optical movement detection, acceleration sensing, magnetic field sensing, gyroscopes, touch and multitouch screen, capacitive proximity sensing, and microphones. Essl and Rohs have also been prolific authors and leaders in the exploration of implementing the wide range of onboard sensors in musical contexts.[12]

Although only some makes and models of phones make all of these sensing parameters available, a typical phone has a far greater range of onboard sensors than a laptop computer, giving the device several advantages over the laptop as a performance device. The handheld nature of the device, coupled with the array of sensors, make it far easier to perform and track gestures that would be awkward to replicate using a laptop. It is far less cumbersome to use tilt

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[10] Georg Essl and Michael Rohs, "Interactivity for Mobile Music-Making," *Organised Sound* 14, no. 2 (2009): 197-207. Their summary for mobile devices is modeled after Eduardo Miranda and Marcelo M. Wanderlay, *New Digital Musical Instruments: Control and Interactions Beyond the Keyboard*, (Middelton, WI: AR Editions, 2006).
[11] Ibid., 198.
[12] Michael Rohs, Georg Essl, and Martin Roth, "CaMus: Live Music Performance Using Camera Phones," in *Proceedings of the 2006 International Conference on New Interfaces for Musical Expression (NIME06)*, Paris, France, 2006, 31-36; Michael Rohs and Georg Essl, "CaMus 2 – Optical Flow and Collaboration in Camera Phone Music Performance," in *Proceedings of the 2007 Conference on New Interfaces for Musical Expression (NIME07)*, New York, NY, USA, 2007, 160-163; Ananya Misra, Georg Essl, and Michael Rohs, "Microphone as Sensor in Mobile Phone Performance," in *Proceedings of the 2008 Conference on New Interfaces for Musical Expression (NIME08)*, Genova, Italy, 2008, 185-88.

on a phone than a laptop, for instance. On the other hand, the smaller screen size and reduced computational capacity of handheld mobile devices are disadvantages in the kinds of tasks they can realistically handle. Complex synthesis algorithms or memory-intensive musical processes are not viable for phones at this time. Hence, a common approach to mobile phone-based application design is to leverage the phone's mobility to offer scaled down 'pocket' versions of existing desktop software, hardware, or acoustic (and less portable) instruments. NanoStudio, DJ Mixer, Theriminator, Animoog, Magic Guitar, Pocket Piano, and iBone are only a few examples of this approach within the commercial sector.

Another current in mobile music development is the creation of modular toolkits and programming interfaces permitting real-time sound synthesis such as FM, wavetable, and additive synthesis. These efforts, primarily situated in academia, are designed to offer open-ended platforms for sound generation in a similar vein as Max/MSP, Pure Data, and RTcmix.[13] They are also clear attempts to attract more composers and programmers to the mobile music community, or to at least integrate existing musical platforms for desktop computing with the advantages of mobile devices. Essl and Rohs (2006) ported Perry Cook and Gary Scavone's Synthesis Toolkit (STK) to Symbian OS and later to iOS to create MobileSTK.[14] This was the first full parametric synthesis environment available on mobile phones.[15] It has since served as the sound-generating platform used in combination with sensor-based projects ShaMus and MiMus.[16] ShaMus was the impetus for the first repertoire-based mobile phone ensemble,

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[13] Cycling74.com; Puredata.info; Rtcmix.org.
[14] Georg Essl and Michael Rohs, "Mobile STK for Symbian OS Audio Support of Symbian OS," in *Proceedings of the International Computer Music Conference (ICMC)*, New Orleans, USA, 2006; Perry Cook and Gary Scavone, "The Synthesis ToolKit (STK)," in *Proceedings of the International Computer Music Conference (ICMC)*, Beijing, China, 1999.
[15] Essl and Rohs, "Interactivity for Mobile Music-Making," 201.
[16] Georg Essl and Michael Rohs, "ShaMus – A Sensor-Based Integrated Mobile Phone Instrument" in *Proceedings of the International Computer Music Conference (ICMC)*, Copenhagen, Denmark, 2007; Misra, Essl, and Rohs, "Microphone as Sensor in Mobile Phone Performance."

founded at the Center of Computer Research in Music and Acoustics at Stanford University.[17] Bryan, Herrara, Oh, and Wang (2010) developed MoMu, an expanded version of MobileSTK built using the iPhone OS SDK, with OSC and FFT capabilities.[18] Essl's SpeedDial (2009) and urMus (2010) are other modular programming languages for the iPhone, essentially written to offer a graphic user interface (GUI) for programmers interested in open-ended musical toolkits.[19] Brad Garton, Damon Holzborn, and Terry Pender similarly ported RTcmix to the iOS to form iRTcmix.[20] For RTcmix users, this allows one to download custom-made musical apps onto the iPhone without the need to 'jailbreak' the phone's operating system. These toolkits operate from the premise of mobile phone as standalone instrument, without need for connectivity to an outside system for sound production or algorithmic processing.

3.1.4 Mobile Phone as Controller

Alternatively, phones can operate as controllers rather than as a primary sound source. As the need has increased for customizable music interfaces to simplify or streamline whatever hardware and software combinations a musician might use, various mobile app developers have authored software for the express purpose of using the mobile phone as a remote control. *TouchOSC*, *Mrmr*, *Control*, *C74*, and *OSCemote* are popular apps that transmit OSC (and in some cases MIDI) messages via wireless local area networks.[21] Most of these apps permit custom

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[17] Ge Wang, Georg Essl, and Henri Penttinen, "Do Mobile Phones Dream of Electric Orchestras?" in *Proceedings of the International Computer Music Conference (ICMC)*, Belfast, UK, 2008.
[18] Nicholas J. Bryan, Jorge Herrara, Jieun Oh, and Ge Wang, "MoMu : A Mobile Music Toolkit," in *Proceedings of the 2010 Conference on New Interfaces for Musical Expression (NIME 2010)*, Sydney, Australia, 2010, 174-77.
[19] Georg Essl, "UrMus – An Environment for Mobile Instrument Design and Performance," in Proceedings of the International Computer Music Conference (ICMC), Stony Brook, NY, USA, 2010.
[20] Brad Garton, Damon Holzborn, and Terry Pender, "iRTcmix – Rtcmix on the iPhone/iPod," June, 2010, accessed February 12, 2013, http://music.columbia.edu/~brad/irtcmix/README.html.
[21] Rob Fischer, *TouchOSC*, http://hexler.net; Eric Redlinger, *Mrmr*, http://code.google.com/p/mrmr/; Charlie Roberts, *Control*, http://charlie-

layout design, but have the downside of working only within local area networks (LANs). This can be problematic in audience participatory concert settings in which connectivity and setup issues may be too problematic for large-scale audience participatory works. Another obstacle is that many of these apps are only available for iOS, or have less stable versions for Android. Within a large audience, the inevitable variety of models and makes of mobile phones makes it impractical for an OS-specific app to be downloaded and implemented within a short setup time. Jesse Allison proposes the use of a phone's web browser as an interface for connecting, eliminating the necessity of operating within a LAN or with a specific app.[22] Oh and Wang (2011) and Knowles (2012) have similarly implemented Ajax programming and Node.js respectively to achieve the same outcomes.[23] Oh and Wang note:

> Especially in consideration with the tremendous growth in popularity of consumer mobile devices with built-in browsers, the mobile web provides us with an ideal setting to enable audience participation in music performances in a manner that is software-free (beyond an internet browser) and less dependent on the hardware (that is, in comparison to building device-specific applications).[24]

In the realm of audience participatory works, an alternative could be to deliberately avoid newer or non-standard technologies in order to establish broader access. Because SMS is a standard feature on nearly all mobile phones, it continues to be a viable option for real-time audience participatory works, where user inclusion and broad access across platforms is more desirable than feature-rich devices.[25]

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roberts.com/Control/; Leo van der Veen, *C74*, http://nr74.org/software/c74.html; Joshua Minor, *OSCemote*, http://pixelverse.org/iphone/oscemote/.

[22] Jesse Allison, "Web-Based Control of Mobile Devices," in *Proceedings of the 1st Symposium on Laptop Ensembles & Orchestras (SLEO 2012),* Baton Rouge, USA, 2012, 82.

[23] Oh and Wang, "Audience-Participation Techniques"; Joshua Knowles, email conversation with the author, November 2, 2012.

[24] Oh and Wang, "Audience-Participation Techniques," 669.

[25] Brucker-Cohen's *SimpleTEXT* (2003), perhaps the most widely performed SMS-based interactive musical work, has most recently been performed in 2008. Still, third party websites such as www.polleverywhere.com offer "Instant Audience Feedback" and can be easily integrated into interactive musical works. Similarly *TweetDreams* (2010) by Herrera, Dahl, and Wilkerson incorporates audience feedback over Twitter. Tweets containing performance-specific search hash tags are projected on screen and sonfied by performers. Brucker-Cohen,

3.1.5 Conclusion

Much of these uses for mobile phones as instruments are reminiscent of Cage's *Imaginary Landscape No. 4* (1951), in which the medium is not so much transformed as it is appropriated for outcomes not originally intended. For the broader public, although the convergence of the mobile phone has increased one's assumptions of what a phone can do, most people do not yet view the mobile phone as a musical instrument in any viable and permanent sense. Marketing efforts by mobile providers certainly have attempted to promote musical capabilities of mobile devices, but it is too early to know whether the mobile phone will be culturally recognized as an instrument the same way traditional acoustic instruments are.[26] For better or for worse, the phone (and all the other devices that are conflated into it; the camera, flashlight, etc.) has its own longstanding cultural presence that interferes with efforts to establish the phone as an instrument.[27]

3.2 Mobility and Spatialization

3.2.1 Introduction

As has been noted previously in Section 2.1, the use of mobile phones within the concert hall has yielded new opportunities for considering how sound is distributed within performance space. Mobile phones have also given composers newfound opportunities to take the concert hall out into town. In many cases mobile phones are used within a network and serve as an extension of network music spatial considerations. Prior to mobile phones and related

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"SimpleTEXT"; Poll Everywhere, accessed February 22, 2013, http://www.polleverywhere.com/; Jorge Herrara, Luke Dahl, Carr Wilkerson, "TweetDreams: a multimedia musical performance made from live Twitter data," accessed February 22, 2013, https://ccrma.stanford.edu/groups/tweetdreams/.

[26] An example is a recent Sprint EVO 4G LTE commercial: sprintnow, "EVO Live (extended)," Sprint, June 1, 2012, video clip, accessed December 7, 2012, Youtube, http://www.youtube.com/watch?feature=player_embedded&v=DuRUXR03CEg.

[27] Ruviaro discusses this obstacle as it pertains to the definition of a laptop plus software as an instrument, and the issue is directly applicable to mobile phones as well. Ruviaro, "From Schaeffer to *LOrks," 23-26.

technologies such as GPS, remote performance was usually realized using non-portable setups: desktop computers, telephones connected to walls, etc. Mobile phones are simultaneously another iteration of a long history of transportable musical instruments as well as a smaller albeit powerful networked instrument. How is musical space and place redefined as a result of these devices? In what ways have GPS technologies been explored in musical contexts? The purpose of this section is to describe how the 'mobility' of mobile phone music is being exploited for artistic purposes, both within and without the concert hall.

3.2.2 Mobile Phones in the Concert Hall

At first glance, mobile phones seem to offer nothing new to spatial considerations, especially within the concert hall. When treated as standalone instruments—that is, using the mobile phone as a primary sound source as opposed to using the phone as a controller forwarding information to another source over a network—, mobile phones do not create any new advantages over acoustic instruments as sound objects within a concert space. For instance, the disbursement of instruments within the audience (as is the case with Levin's *Dialtones: A Telesymphony*) is not a significant deviation from other acoustic works that situate the performers in the aisles or in a choir loft. Nevertheless, unlike other portable musical instruments such as the piccolo, trumpet, or even the voice, mobile phones permit one to separate the location of sound generation from the location of the performer, even over significant distances. In Levin's *Dialtones* the performer's instrument—that is, at least a portion of it—is in the hands of the audience members. The network creates a different type of performer presence than mere physical presence on the stage. That the phones put into play here are the property of the audience members, and familiar to them in completely different contexts apart from the concert hall, adds to the novelty. It is within this context of network music that we begin to see mobile phone music offering new avenues for spatial considerations.

The use of mobile phones as networked controllers certainly expands possibilities to separate user input from the sound source.[28] Dislocated sound is a central aspect of the network music tradition, and according to Golo Föllmer, has significant ramifications on the context of space and presence.[29] In brief, the virtual space of the computer and the Internet is not tied to Euclidian, three-dimensional space in terms of perception and orientation. Föllmer notes:

> Spatial dimensions are nothing but a metaphor meant to help cognition do the shift from our well-known three-dimensional world into the electronic world of indefinite dimensionality inside the computer and the Internet.[30]

This plasticity of network configuration leads to complications in establishing a sense of a presence among participants. "Where there is no physical space, leaving users no way to encounter each other physically, users can only confirm the actual presence of each other by taking a specific action. The action would thus relate previously unrelated elements in such a way that a group can establish a collective meaning."[31] In the concert hall, where participants *do* encounter each other physically, the same issues are nonetheless present when networked controllers are part of the musical performance. A composer or performer of networked instruments needs to convey to the audience a cause-and-effect relationship between performance action and sonic outcome "in such a way that a group can establish a collective meaning."[32] If this relationship is not made explicit, confusion over who is making what sound can set in and hinder the dramaturgy of the performance.

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[28] In many performance situations, especially within the concert hall, other wireless controllers can perform the same functions as mobile phones, and could be used interchangeably. The added value that smartphones offer is the combination of telephony with other wireless protocols, plus their ubiquity. That said, not all pieces using mobile phones leverage all of these aspects. The rise in popularity of using mobile phones as opposed to comparable wireless controllers may be simply a result of convenience.

[29] Golo Föllmer, "Electronic, Aesthetic, and Social Factors in Net Music," *Organised Sound* 10, no. 3 (2005): 185-92.

[30] Ibid., 185.

[31] Ibid., 185.

[32] Ibid., 185. See also Schloss, "Using Contemporary Technology in Live Performance." Levin et al. took steps to make the various complex calling sequences visually clear: they placed a giant mirror over the audience, with LED lights affixed to each seat and corresponding to a ringtone.

One particularly effective example of the mobile phone used as controller within a concert piece is Jason Charney's *Compass* (2011).[33] A single performer uses a mobile phone as a controller to trigger and control sounds that are played within a quadrophonic array of speakers. Though there is nothing inherently new in terms of spatialization, the contribution of the mobile phone in this instance is dramaturgical: due to the wireless nature of the phone as a controller, the performer can be situated on stage and push sounds to various speakers in a way that allows the audience to see the connection of gesture to sound. As Charney twists the phone within a horizontal plane in a deliberate and slow manner using the onboard compass sensor, drones pan from one speaker to the next. The shake gesture is linked to more percussive and bell-like sounds.

The challenge of maintaining cause-and-effect connections between controllers and sounds becomes more complex when multiple performers are onstage. At the same time, deliberately concealing who is doing what can be leveraged for dramatic effect. In the MoPho's first performance on the 11th of January 2008 at Stanford University's CCRMA Stage, they were cognizant of the role of spatialization that could take place within the concert space.[34] Ge Wang's pair of pieces *Drone In/Drone Out,* bookending the concert program, began with some members of the ensemble sitting, disguised among the audience. As the remaining players walked into the space with phones droning, the concealed players joined and helped surround the audience with a total of twelve players with phones. The *Drone Out* at the end of the concert also explored additional spatial configurations before players exited or returned to their original seats in the audience. Other pieces also explored spatialization in the MoPho ensemble: Henri Penttinen's *The Saw* (2008) situates performers in a semicircle and explores panning effects

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One could then see when a sweep across the audience would take place as well as hear it. Golan Levin, "Dialtones: A Telesymphony."

[33] Jason Charney, "Compass," 2011, accessed December 12, 2012, http://www.jasoncharney.com/compass/.

[34] For more details on the following pieces, see Wang et al., "Do Mobile Phones Dream of Electric Orchestras?"

within the ensemble. Chris Warren's *phoning it in* (2008) is primarily concerned with diffusing a fixed media piece in space. In each of these instances, the movement of sound among performers or throughout the space becomes a primary compositional focus.

When treating mobile phones as standalone instruments rather than controllers, MoPho addresses the amplification limitations of mobile phones by using wearable speakers attached to gloves. This allows for sound generation to be physically tied to a performer the same way a traditional acoustic instrument would be. At the same time, the networked functions of the devices allow for sounds to travel from one person to the next. This feature of 'passing the sound' has been used in several networked compositions.[35]

With *4Quarters* I confront the problematic of establishing presence between performers—and making their actions clear to the audience—by creating a visual projection displaying all actions by all users in one central location. Any change to the sound initiated by a performer has a corresponding visual component (e.g. a volume adjustment made on the phone will match a slider on the projection). The sound source is also centralized in a stereo speaker image. When viewing user performance as an audience member, the task of determining who is doing what is assisted by viewing the projection, but it does not make all actions explicitly clear unless performers dramatize their actions by exaggerating movements.[36]

3.2.3 Mobile Phones - Bringing the Concert Hall into Town

In addition to networks, broadcast media, and especially the Internet, mobile phones have been one of several kinds of digital tools that allow artists to situate musical performance and sound art outside the concert hall or gallery.

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[35] Luke Dahl's *SoundBounce* (2010) and Jesse Allison's *Divergence* (2012) are two excellent pieces using mobile devices to pass sounds from performer to performer. See also Gil Weinberg, Roberto Aimi, and Kevin Jennings, "The Beatbug Network – A Rhythmic System for Interdependent Group Collaboration," in *Proceedings of the 2002 Conference on New Instruments for Musical Expression (NIME-02)*, Dublin, Ireland, 2002, 1-6.

[36] In many respects the need to dramatize actions is no different than performance practice considerations for traditional musical instruments.

Many of the first serious efforts to use mobile phones in public spaces to generate sound were tied to civic activism. Limited by the technology available at the time, these sound art pieces used SMS text messaging and text-to-speech software to amplify anonymous messages within a public space. Examples include Harwood and Fuller's *Text.FM* (2002), Dobson's *AgoraPhone* (2002), and Troïka's *Tool for Armchair Activists* (2005).[37] Eacott et al.'s *Intelligent Street* (2004) represents one of the first SMS-based interactive music environments. Users collectively affect a shared soundscape via text commands. Resulting changes are played over loudspeakers placed over a high-traffic public walkway.[38]

The 'flash mob' performance style represents a second musical use of mobile devices in public spaces. Because these works typically foreground choreographed movements or dances as opposed to music-making, they are not considered in depth here. Some examples of this trend include Ligna's *Radio Ballet* (2002-03) and Improv Everywhere's *Mp3 Experiments* (2004-12), among others.[39] While these represent the most popular type of performance art ported from a concert space into the community, flash mobs are not so much reliant on mobile phone technology as the Internet for coordination and planning.

Prior to GPS-enabled mobile phones, Tanaka and Gemeinboeck (2006) experimented with using participants' locations as a musical controlling parameter. Participant physical positions within a concert space were deduced by determining each phone's signal strength as received

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[37] Matthew Fuller and Graham Harwood, "Text.FM," accessed December 20, 2012, http://basecamp.netbase.org/e_index.html; Dobson, "AgoraPhone"; Troïka, "The Tool for Armchair Activists," accessed December 20, 2012, http://goodparticipation.com/2010/01/the-tool-for-armchair-activists-by-troika/.

[38] Eacott et al., "Intelligent Street."

[39] As these pieces predate the widespread use of smartphones, neither of these works make use of mobile phones; *Radio Ballet* uses portable radios with a central coordinator giving instructions via radio broadcast, whereas *Mp3 Experiments* generally use mp3 players with a central coordinator giving instructions based on an agreed time in which participants synchronously push the play button on their own devices. Ligna, "Radio Ballet"; Improv Everywhere, "The Mp3 Experiments."

over a GSM cell antennae.[40] This proved to be difficult to implement because participants were reluctant to move around the space during performance.[41]

3.2.4 GPS and mobile phone music

As GPS technology became available, many mobile phone works emphasizing *mobility* featured embedded sounds onto a virtual soundscape or 'soundmap' via geotagging. Thus far, there have been two main approaches to implementing GPS in musical contexts: the expansion of the concert hall or performance space on a larger geographic scale, and the sound walk. First, GPS affords one to re-conceive of the space in which a musical performance resides, in many cases expanding the concert hall into public space, at times on a massive scale. Choloniewski's *GPS-Trans* pieces (2000-01) both predate the advent of GPS-enabled mobile phones, but exemplify this approach of the 'spread out' concert hall. The Smule Ocarina presents a *World Listener* view, where one can see locations of other Ocarina players, and hear one another through GPS-tagged sound snippets that are recalled and played. Although this feature does not create a concert space, overwhelming user feedback indicates that the anonymous sharing of music, a self-chosen username handle, and GPS-location is nonetheless compelling.[42]

Sound walks with recorded media predate mobile phones and GPS technology, but have become more popular because of accurate location tracking. GPS-enabled devices equipped with headphones can allow participants to explore terrain in via 'augmented' soundscape, with digitally recorded sounds corresponding to specific geographic locations and made accessible once a participant arrives in proximity to a given tagged location. Layla Gaye et al.'s *Sonic City* (2003) incorporated GPS locative devices as one of several sensors to allow a user to interact

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[40] Atau Tanaka and Petra Gemeinboeck, "A Framework for Spatial Interaction in Locative Media," in *Proceedings of the 2006 Conference on New Interfaces for Musical Expression (NIME06)*, Paris, France, 2006, 26-30.
[41] Atau Tanaka, conversation with the author, 2010.
[42] Wang, "Designing Smule's iPhone Ocarina," 306.

with the urban landscape.[43] Mark Shepard's *Tactical Sound Garden* (2007) facilitates peer-to-peer interaction by 'planting' or 'pruning' sounds at a specific urban location via geotagging over wi-fi.[44] Using the garden metaphor (i.e. one plants a seed, another sews), this work establishes a presence between users separated by time but sharing the same geographic location. Freeman et al.'s *Urban Remix* (2012) is a more recent project with the same ideal of establishing a community through shared sound and location.[45] The concept of establishing presence between individuals over great expanses of time and space is also found in Teri Reub's site-specific sound installations *Core Sample* (2007) and *Elsewhere:Anderswo* (2009), both of which allow visitors to explore a location through sound by using headphones connected to GPS-enabled portable devices. Carter and Liu's *Location 33* (2005) is yet another approach to the sound walk, using geotagging to create an augmented experience when listening to an album.[46]

3.2.5 Conclusion

Although my personal interest in using mobile phones is not motivated by the mobility of mobile phones so much as it is the ubiquity of the devices, it is clear that many artists are interested in the possibilities of working with locative media and sound dislocation. Mobile phones can allow communities to emerge through shared sound in like manner to an online forum, which allows conversations to take place without regard to physical location or proximity through time. It is unclear whether these types of interactions have staying power within music communities or even with the broader public. For now, these efforts are largely experimental. It is plausible that mobile music will endure, like many online forums, as a special-interest group.

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[43] Gaye et al., "Sonic City."
[44] Shepard, "Tactical Sound Garden [TSG] Toolkit."
[45] Jason Freeman, Carl DiSalvo, Michael Nitsche, & Stephen Garrett, "Rediscovering the City with UrbanRemix," *Leonardo Music Journal* 45, no. 5 (2012): 478-79.
[46] Carter and Liu, "Location33: A Mobile Musical."

3.3 Mobile Phone Ensembles

3.3.1 Introduction

In the effort to define the mobile phone as an instrument worthy of long-term experimentation and dedicated performance practice, the concept of mobile phone ensembles has emerged as a plausible format for developing the phone-as-instrument. In this section I will examine the state of mobile phone orchestras, their origins, developments, and their application within the concert hall paradigm. The following questions will be explored: To what extent are mobile phone orchestras successful as ensembles with an audience? Is the traditional orchestra an appropriate analogy for emulation with mobile phone, or do these new instruments suggest a different model as a basis for development? Do mobile phones suffer from a 'gimmick factor' that will be difficult for a general public to accept as instruments?

3.3.2 MoPho Origins

The Stanford Mobile Phone Orchestra (MoPhO) was created in 2007 under the direction of Ge Wang, Georg Essl, and Henri Penttinen. Essl subsequently replicated the orchestra at the University of Michigan in 2009 with the Michigan Mobile Phone Ensemble (MiPhos), and Penttinen founded the Helsinki Mobile Phone Orchestra.[47] These ensembles are extensions of the laptop orchestras founded at Princeton University and elsewhere.[48] Generally speaking, both laptop and mobile phone orchestras have been guided by a particular set of aesthetic goals:

- Reclaim a community-based paradigm for making music from within the computer music tradition, especially within the institutional domain.[49]

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[47] Oh et al., "Evolving The Mobile Phone Orchestra," 83. See Stanford Mobile Phone Orchestra, accessed January 3, 2013, http://mopho.stanford.edu/; Michigan Mobile Phone Ensemble, accessed January 3, 2013, http://mopho.eecs.umich.edu/; and Helsinki Mobile Phone Orchestra, accessed January 3, 2013, http://www.acoustics.hut.fi/projects/helsinkimopho/.
[48] Laptop ensembles have been well established both within academia and without, with expansions to orchestras of larger sizes surfacing around 2005. For more information on the history of laptop ensembles, see Trueman, "Why a Laptop Orchestra?"
[49] This return to collaborative computer music-making is presented as a departure from studio-based computer music composition, a format that has become decentralized (due to hardware

- Promote live real-time performance of digital media as opposed to studio-based fixed media.
- Champion experimentalism and discovery as part and parcel with the emergence of the ensemble, and its corresponding instruments and performance practice.
- Create an ensemble that allows a lower barrier for entry than traditional orchestras.[50]
- Attempt to take the best virtues of a traditional orchestra while also solving some of the inherent disadvantages.
- Generate a repertoire of works created for these ensembles to help evolve the model, establish best practices, and develop a range of performance difficulty from easy to advanced works.

Other mobile phone ensembles of various configurations include Yamaha's Mofiano Mobile Orchestra, Mobile Phone Orchestra Berlin, and the KAIST Mobile Phone Orchestra (KAMPO).[51]

Institutionalized ensembles within university settings yield obvious benefits in promoting and evolving mobile phone ensembles. There is a natural accretion of works over time as students cycle through the classes and present projects and concerts. Teaching the ensemble as a course permits a steady influx of students exposed to the problems inherent to performing with new instruments. The growing community can then glean best practices and infuse them in the next round of classes. This has proven to be applicable for both laptop ensembles and mobile phone ensembles.

In spite of the similarities between mobile phone ensembles and laptop ensembles, there are some distinguishing differences that influence performance and composition considerations.[52] First, for getting to and from a venue, all equipment for mobile phone ensemble can be carried in a standard size laundry basket or crate by one person. There is no

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and software becoming cheaper and brought to the home) and fragmented into isolated workspaces. See Trueman, "Why a Laptop Orchestra?" 177.

[50] Ibid., 175. Trueman states, "Does it make sense, after all, to create a new large ensemble like the orchestra which requires its players to begin practice at a young age and prevents all but a select few from ever reaching a professional or near-professional level?"

[51] Yamaha, "Mofiano Mobile Orchestra," accessed January 3, 2013, but no longer available, http://www.yamaha.co.jp/product/lsi/mofiano/mmo/; see PingMag, "Yamaha Mobile Orchestra," August 7, 2008, video clip, accessed March 1, 2013, Youtube, http://www.youtube.com/watch?v=90556od8IsI&feature=share&list=PL8CBD661CD703E598; MoPhoneOrchestraBln, "MoPhOs Part 1 – Gedrone," June 16, 2009, video clip, accessed February 6, 2013, Youtube, http://www.youtube.com/watch?v=DhZ9g5U81io; KAIST Mobile Phone Orchestra, accessed January 3, 2013, http://kampo.kaist.ac.kr/.

[52] Georg Essl, "The Mobile Phone Ensemble as Classroom," in *Proceedings of the International Computer Music Conference (ICMC)*, Stony Brook/New York, USA, 2010.

need for a dedicated rehearsal space. By contrast laptop orchestras classes require a location where equipment can be set up for the duration of a course, creating a difference in rehearsal time allocation for students. In the concert paradigm, laptop ensembles do not yield the same in-motion performance opportunities that mobile phones do. For many mobile phone-based pieces choreography has been brought to the foreground in performance because it helps establish motion as a defining quality of mobile phone instruments.[53]

The current trend in developing mobile applications for ensemble performance has benefited from the proliferation of mobile platforms—not just phones, but other consumer devices such as Nintendo DS or PSP—and their corresponding SDKs and APIs.[54] This has created fertile ground for a variety of mobile performance scenarios outside of academia. One common approach to mobile performance is to create a jam session using multiple mobile app instruments. This 'mobile instrument mashup' concept has taken shape in both edited YouTube video performances and live concert settings.[55] This can be done as a single performer or as a group.

3.3.3 Ensemble and Orchestra as Metaphor

The words 'ensemble' and 'orchestra' have been used interchangeably in describing coordinated group mobile phone performance. Still, the words carry with them deep semantic

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[53] In the inaugural Michigan Mobile Phone Ensemble performance at the 2009 Premiere Final Class Concert, Colin Neville and Owen Campbell's *Shepard's Escher* explores motion in both pitch (using the Shepard-Risset glissando) and space (through a series of choreographed motions among players). In *Space Pong* (2010) by Gayathri Balasubramanian, Billy Lau, and Lubin Tan, performers 'pass' sounds from device to device using a tossing gesture between performers. See "The Michigan Mobile Phone Ensemble @ Premiere Final Class Concert 2009," December 9, 2009, accessed February 7, 2013, http://mopho.eecs.umich.edu/events/finalclassconcert09.html; EECSatUM, "Space Pong – Michigan Mobile Phone Ensemble," January 28, 2011, video clip, accessed February 9, 2013, Youtube, http://www.youtube.com/watch?v=ejocScps1sk&feature=youtu.be.

[54] Oh et al., "Evolving The Mobile Phone Orchestra," 83.

[55] Examples include HirnW, "iBand," February 17, 2008, video clip, accessed January 3, 2013, Youtube, http://www.youtube.com/watch?v=Mh0VX74alwk; thehighams, "iPhone Music Apps," May 30, 2009, video clip, accessed January 3, 2013, Youtube, http://www.youtube.com/watch?v=tevO66NT1uE; Crystal Young-Otterstrom, "iPhone Sextet No. 1," Salty Cricket Concert, premiered April 11, 2009, Salt Lake City.

meanings and cultural connotations, generating debate as to which term accurately describes the nature of the performing group that uses mobile phones as instruments. This debate is accentuated because mobile phones can easily blur the boundaries between audience, performer, and composer, as discussed in Chapter 2. By using the term 'orchestra,' do mobile phone ensembles emulate traditional classical orchestras, or is the usage even appropriate?[56] When posed this question, MiPhos director Georg Essl responded:

> I actually do not see MoPhos as "emulating" traditional orchestras, but rather rethinking the notion of ensemble play with new technological possibilities. But by labeling it orchestra, it helps us not only think it as completely new, but question embedded assumption into what makes an orchestra itself. Standard roles do not just disappear but are either adopted or complexified, perhaps modified and re-instituted. Reference to what we already know (traditional ensemble play) is one of a range of possible ways to explore the space and I think it's a good one, but not the only one. …Mobile phones in ensembles can be radically new and very traditional and what is exciting is to allow the exploration along both these lines.[57]

One avenue of mobile phone ensemble exploration thus far has been audience participation, as discussed in Chapter 2 and found in pieces such as Jiuen Oh's *Heart* (2010), Jieun Oh and Ge Wang's *Converge 2.0* (2010), Jorge Herrara, Luke Dahl, and Carr Wilkerson's *TweetDreams* (2010), and Nick Kruge's *Madder Libs* (2010).[58] But for Essl, audience participation does not necessarily negate the use of the orchestral metaphor:

> I don't think that audience participation *per se* explodes the frame. One can easily envision orchestral performance that diffuses the boundary without a use of mobile devices and I'm sure there are historical cases. What technology does is make

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[56] When Dan Trueman and Perry Cook created PLOrk, they had in mind non-classical orchestras as well, such as a gamelan orchestra. See Trueman, "Why a Laptop Orchestra?" 174.
[57] Georg Essl, email interview with author, January 29, 2013.
[58] Oh and Wang, "Audience Participation Techniques," 670; Ibid., 668; Luke Dahl, Jorge Herrera, and Carr Wilkerson, "TweetDreams: Making Music with the Audience and the World Using Real-Time Twitter Data," in *Proceedings of the International Conference on New Interfaces for Musical Expression (NIME)*, Oslo, 2011, 272-275; Nick Kruge and Ge Wang, "MadPad: A Crowdsourcing System for Audiovisual Sampling," in *Proceedings of the International Conference on New Interfaces for Musical Expression (NIME)*, Oslo, 2011, 185-190. In the case of *Madder Libs*, the mobility of phones was used to capture audio samples generated by the audience. This work became the basis for the mobile app *MadPad*, which is discussed in chapter 1.

> participatory dissemination easy. Moving a cello, a harp or a timpani into the audience is tricky. Moving an app on a mobile device is not.
>
> So in a sense yes, there is a difference in opportunities. But that doesn't mean that one cannot refer to potential similarities or perhaps even mix it. Hybridizing that into a distributed participatory setting would not obsolesce the orchestra or conductor who may well be participating if not integral to the performance.[59]

3.3.4 Mobile Phone Ensemble Performance Practice

Thus far in mobile phone ensemble music, the process for composition and performance relies very much on improvisation and experimentation. This is similar to laptop ensembles that carry out the same procedures. Unlike traditional instruments that require physical modifications to the instrument to modify acoustic results, the hardware for mobile phone instruments stays more or less constant, meaning that the instrument can be refined via software without any destructive physical side effects. This means that the instrument can evolve alongside performance and compositional decisions.

The process can be generally described as follows: when a composer designs a mobile instrument for ensemble use, performers first undergo an experimentation process with the instrument (or instruments) as a group. In rehearsals or 'jam sessions,' the ensemble explores new sounds and ideas that can then be implemented into concert performance. During the process of improvisation with the mobile instrument, the ensemble will discover the features that work effectively while also identifying problems, bugs, and breakdowns. This creates a feedback loop leading to tweaks and revisions of the app.

At the University of Michigan students taking the class *Mobile Phones as Ensemble Musical Instruments* have a goal of composing pieces for an end-of-semester concert, with the idea of building instruments from scratch. Students first undergo a rigorous introduction to coding languages Objective C, C, and C++, as well as exposure to the iPhone SDK. They also build their own wristband speakers. The second unit of the class focuses on preparation for

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[59] Essl, email interview with author, January 29, 2013.

performance, with an array of topics such as spatial arrangements, composing for distributed instruments, dramaturgy, and choreography.[60] "Students engaged with different forms of performance, free-form unguided improvisation, guided improvisation through conducting, traditional, graphical and computer-guided scores."[61] In this second unit of the class students work on generating their own instruments, and work in pairs to compose a piece that uses their newly built instruments.

3.3.5 Visual Communication

During improvisation a group may stumble on a combination of sounds that is particularly effective, and will seek to replicate it again for the concert. When these 'happy accidents' occur, the group typically has to stop and ask each other who made what sound.[62] This becomes particularly difficult if there is no special consideration made to add a visual component to represent audio data, or if all sounds from multiple players funnel through a stereo speaker image. With mobile phones visual information can be disseminated through the displays, with messages transmitted wirelessly between devices.[63]

Visual clarity is needed between the audience and performers as well, and poses different challenges in performance strategy. Watching performers stare at mobile phones can be very dull from an audience perspective. In laptop ensembles the same symptom—commonly known among laptop ensemble enthusiasts as the 'email syndrome'—has been addressed in scholarly

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[60] Essl, "The Mobile Phone Ensemble as Classroom."
[61] Ibid.
[62] Tim Merritt, Weiman Kow, Christopher Ng, Kevin McGee, and Lonce Wyse, "Who Makes What Sound? Supporting Real-time Musical Improvisations of Electroacoustic Ensembles," in *Australian Conference on Computer-Human Interaction (OzCHI)*, Brisbane, Australia, 2010, 112-119.

[63] Jorge Herrara's mobile phone instrument *interV* uses OSC messages to send and receive display instructions. See Oh et al., "Evolving the Mobile Phone Orchestra," 85-86.

discourse.[64] Likewise, Essl notes that audience communication is a crucial aspect of MiPhos concert planning, and is highlighted throughout the course:

> We spend a lot of time worrying about communicating pieces. There are [at least two] reasons for this. One is that we cannot lean on audience expectations. Almost anything we do is likely new and needs to stand on its own in terms of conveying its point. The second is that just moving around a multi-touch screen does not have a strong performative character from the audience's perspective. That a performance looks no different than checking email is a concern for laptop ensembles and it is certainly a concern for mobile phones.[65]

This attention to audience communication is reflected in *There Is No I in Guitar* (2011), a MiPhos piece by Lizzie Paris, Ricardo Rodriguez, and Scott Wagner.[66] Six performers act as fingers on a guitar neck while a seventh performer acts as the guitar strummer. The instrument is distributed among these performers, where the six 'fretted' performers determine the pitch for the seventh performer to strum. The performers likewise move over a grid taped to the floor and form visual representations of fingers on a guitar fret to form chords. Though the choreography and physical position does not have an acoustic bearing on the music played, the visual formation of standard guitar chords is integral to communicating what each performer is contributing to the sonic results.

4Quarters addresses the issue of visual communication for both performers and audience by allowing all performers (and audience members) to see a visual representation of any performance gesture at all times. During jam sessions when honing desirable sounds is the primary focus, the ability to isolate events visually increases the efficiency in determining who

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[64] Timothy Edwards and R. Benjamin Sutherland, "Eyes Off the Screen! Techniques for Restoring Visual Freedom in LEO Performance," in *Proceedings of the 1st Symposium on Laptop Ensembles & Orchestras (SLEO)*, Baton Rouge, 2012, 33-40.
[65] Essl, email interview with the author, January 29, 2013.
[66] Lizzie Paris, Ricardo Rodriguez, and Scott Wagner's "There is no I in Guitar" (2011). See EECSatUM, "There Is No I In Guitar – Michigan Mobile Phone Ensemble," May 2, 2011, video clip, accessed January 30, 2013, Youtube, http://www.youtube.com/watch?v=5Omiskx-iFA&feature=share&list=PLCDF596A40CF11DA2.

makes what sound. This is especially helpful because of the acoustic dislocation that naturally occurs with all players sharing the same sonic output through stereo speakers.

3.3.6 Ensemble coordination

For ensemble works that use mobile phones as standalone instruments, traditional methods for coordination apply. Using a conductor is a logical way to give performers visual cues and assist in the coordination of gestures. Nevertheless, one advantage that both laptop and mobile phone orchestras can have over their acoustic counterpart is that a networked internal clock can ensure synchronization of musical events.[67] This can circumvent normal performance limitations created by the time it takes to react to other instruments (particularly in large ensembles, where space and the speed of sound become relevant). The conductor can then take form in a synchronized laptop display.[68]

In some cases the role of conductor can be irrelevant, or at least elude a clear definition. In *Glow Music* (2011) by Robert Alexander et al., the conductor has a flashlight with color filters.[69] The performers have control over timbral content but otherwise hold their phones in such a way that the conductor can shine a light on them. The phone's light sensor is mapped onto volume, thus allowing the conductor to conduct but also partly perform the piece. In *Shepard's Escher*, the conductor is performer as well, and provides visual cues to allow the group to coordinate movements.[70]

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[67] Trueman, "Why a Laptop Orchestra?" 175-76.
[68] Devin Kerr and Eric Lapointe, *The Infinitesimal Ballad of Roy G. Biv*, (2009). See "The Michigan Mobile Phone Ensemble @ Premiere Final Class Concert 2009," December 9, 2009, accessed February 7, 2013, http://mopho.eecs.umich.edu/events/finalclassconcert09.html.
[69] EECSatUM, "Glow Music – Michigan Mobile Phone Ensemble," May 2, 2011, video clip, accessed March 1, 2013, Youtube, http://www.youtube.com/watch?v=ujlPORoZJGY&feature=share&list=PLCDF596A40CF11DA2.
[70] *Shepard's Escher* is the first piece on this concert-length video: um, "iPhone Premiere Public Concert," December 11, 2009, video clip, accessed February 7, 2013, Youtube, http://www.youtube.com/watch?feature=player_embedded&v=Qp3dMbI94_Q.

Other mobile phone ensemble configurations can demand coordination, but in ways where timing must be choreographed rather than synchronized through visual cues or an automated clock. This is especially true for 'distributed' instruments, where sonic output is brought to pass through the coordinated efforts of multiple players, as is the case in *There is No I in Guitar*.

3.3.7 Popular Growth of Mobile Phone Ensembles

With the institutional model of creating ensembles that focus on defining the mobile phone as an instrument, there is an inherent conundrum in trying to popularize and expand these efforts. Mobile phone ensembles that require complex networking, multi-channel speaker arrays, and/or speaker gloves are not likely to be replicable outside of an academic setting. For the sake of argument, if we call the Stanford MoPhO and Michigan MoPhO the 'professional' versions of mobile phone ensembles, it would be difficult for low-tech amateur ensembles to replicate the same setup and access the same repertory of works. It is also possible that wearing speaker gloves will never catch on. In spite of its pragmatism in terms of sound dispersal, speaker gloves may be viewed as too outlandish to gain widespread social acceptance.

A second challenge facing mobile phone ensemble development is creating a central access point for the growing repertory of works. Oh et al. states:

> With the ease of software development comes proliferation of instruments, and consequently these "soft instruments" have become more or less disposable items: often times, an instrument gets written for a specific piece and gets abandoned thereafter.[71]

This problem of instrument 'one-offs' has been documented elsewhere, and in some ways the problem is endemic to any software instrument, since both hardware and software evolve so rapidly.[72] Stephen David Beck and Chris Branton (2012) at Louisiana State University have attempted to address this issue of accommodating the growth of both mobile phone ensembles

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[71] Oh et al., "Evolving The Mobile Phone Orchestra," 86.
[72] See Lansky, "A View from the Bus," 108; Perkis, Brown, and Bischoff, "Bringing Digital Music to Life," 28-29.

and laptop orchestras by creating the Laptop Ensemble Library & Archive (LELA).[73] The project is still in its infancy, as to date there are only seven items archived.[74]

3.3.8 Conclusion

If one looks to the evolution of the chamber orchestra for comparison, it is clear that developments with mobile phone ensembles are only in an early stage. Various ensemble sizes, formats, and configurations will likely evolve as the technology changes and the strengths and weaknesses of the instruments become clear. Essl states:

> My attitude is that we do not know what we are doing just yet and we need to explore and explode the frame. That this can be misunderstood or not always lead to the most amazing results is part of the equation. Symphonic orchestral music had some 200 years to refine itself; we are now in the fifth year of working on this and I think it is getting richer and more refined. I hope we stay as broad as possible for as long as possible. We are in a non-canonized field and now is the time to go crazy.[75]

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[73] Stephen David Beck and Chris Branton, "LELA: Laptop Ensemble Library & Archive," in *Proceedings of the 1st Symposium on Laptop Ensembles & Orchestras (SLEO),* 2012, Baton Rouge, LA, 27-30.
[74] See "Laptop Ensemble Library & Archive (LELA)," Louisiana State University, accessed January 9, 2013, http://lela.cct.lsu.edu/lela/items.
[75] Essl, email interview with author, January 29, 2013.

CHAPTER 4. MOVING TOWARD DESIGN

4.1 Instructions, design considerations, and inviting interaction

4.1.1 Introduction

The preceding chapters have mainly been focused on providing context for the ways in which mobile phones are used in music. The stage is now set for turning toward the architecture and design of *4Quarters*. In this chapter I will focus on how the *4Quarters* instrument empowers novice lay users to interact with the interface and with other participants, and I will describe the evolution of its design, network configuration, server interface, audio content, and performance assignments.[1]

4.1.2 Evolution of design

In its original conception *4Quarters* was intended to accommodate a wide variety of devices situated in the realm of audience participation. Similar to Joshua Knowles and Joo Youn Paek's *3001: Massively Multiplayer Musical Instrument* (2007), a visual projection would show all participants' activities.[2] The initial visual design was intended to correspond to the familiar 12-key interface found on mobile phones. Various types of assignments were conceived to work with the 12-key tactile interface. Preliminary designs anticipated multiple phones communicating keypresses to one central server, with all sound processing occurring on that server. Participants would link in by dialing a phone number, and DTMF keypresses would be captured via Asterisk and route the data to Max/MSP.[3]

The arrival of the iPhone in 2007 introduced new possibilities for data input and interface considerations, such as customizable interfaces with sliders, additional buttons, and colors. Latency with wi-fi was also much less of an issue, and subsequently plans to use DTMF and

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[1] For a list of definitions of technical terms throughout this chapter, see Appendix B – Glossary of Technical Terms.
[2] Knowles and Paek, "3001: Collaborative Musical Gameplay."
[3] Digium, "Asterisk."

Asterisk as the network protocols were abandoned in favor of OpenSoundControl—a network-based data protocol similar in function to MIDI—and a wireless local area network (LAN).[4] The addition of these new possibilities was also made to prepare for the transition to the time when most phones worldwide will be smartphones, a shift that is clearly underway.[5] This is the current state of development of *4Quarters*, although recent trends among smartphone developers indicate a move away from downloadable apps and toward integrated browser-based user input using JavaScript, Node.js, and web sockets such as Socket.io.[6] This browser-based approach is an attractive direction because it eliminates the need for platform-specific devices and likely reduces startup time, and further development of *4Quarters* will certainly explore it.

4.1.3 Network configuration

The main software environment of *4Quarters* is designed in Max/MSP and authored as a standalone application with iPhone and iTouch devices serving as controllers, sending user input via OpenSoundControl over a wireless network. TouchOSC is the current client app (the application running on each phone), which sends and receives data to and from the *4Quarters* client application, which runs on the central 'server' computer (see Figure 4.1).[7] Outgoing messages from the iPhone/iTouch control the following sonic parameters: sound file selection, looping, volume, panning, and frequency equalization (EQ). These messages each have a corresponding visual indication on the *4Quarters* interface. This interface has been designed to be projected onto a large screen that can be seen by all participants, facilitating the social aspects of performance. With this correlation and two-way communication between server and

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[4] Matthew Wright, "Open Sound Control: an enabling technology for musical networking," *Organised Sound* 10, no. 3 (2005): 193-200.
[5] "Smartphones will dominate market in 2013," *SFGate*, March 4, 2013, accessed March 4, 2013, http://www.sfgate.com/business/article/Smartphones-will-dominate-market-in-2013-4327775.php.
[6] "Javascript," Mozilla Developer Network, last modified January 1, 2013, accessed January 10, 2013, https://developer.mozilla.org/en-US/docs/JavaScript; "Node.js," accessed January 10, 2013, http://nodejs.org/; Guillermo Rauch, "Socket.IO," posted 2012, accessed January 10, 2013, http://socket.io/.
[7] Fischer, "TouchOSC."

client, the *4Quarters* system fits Fishkin's (2004) description of a tangible user interface (TUI).[8] Audio playback and processing is handled within *4Quarters*, with its stereo image output audio routed to external speakers that provide a sonic image of size and detail to serve both the performers and the audience.

Data received on the client side (each iPhone/iTouch) from the central computer provide visual feedback reinforcing the interface correspondence between the main video projection of the *4Quarters* application and the screens viewed on the each phone.

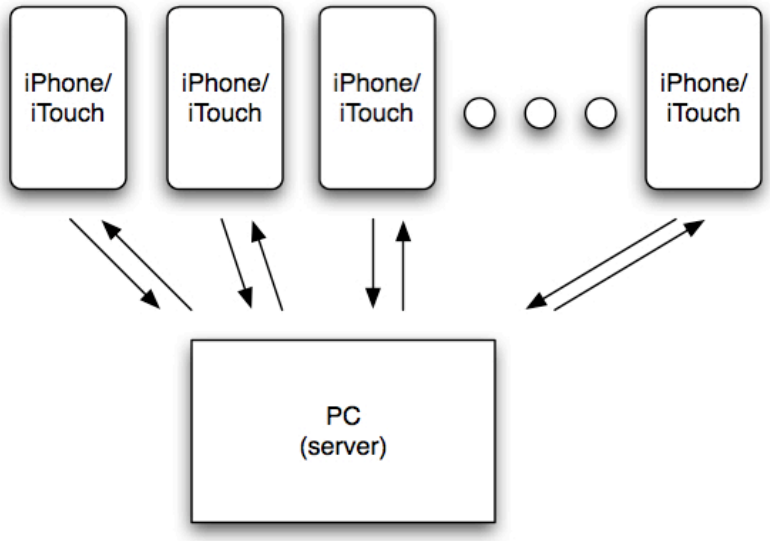

Figure 4.1. Up to twelve iPhones send and receive OSC messages to/from a server via a wi-fi local area network.

4.1.4 Server Interface

The *4Quarters* server interface has retained the 12-key concept as an interface orientation, a carryover from the initial, pre-smartphone design. Keypresses from each mobile phone map onto a 4x3 grid interface (numbered 1-12), with the interface showing four iterations of this grid, each uniquely colored to clarify its identity (see Figure 4.2). Each of the four grids is designated

[8] Kenneth P. Fishkin, "A taxonomy for and analysis of tangible interfaces," *Personal and Ubiquitous Computing* 8, no. 5 (2004): 347-358.

as one 'layer' of the music and represents twelve sound files available for playback, making for a presentation of 48 samples at any one time. The color-coding of the four layers serves as a helpful indicator in situations where multiple participants work to control one layer of sound. For instance, 'team red' may have one person in charge of sound file selection, another person controlling volume, and a third person shaping the EQ. Ideally the *4Quarters application* will be projected on a large screen so that all participants can see clearly what is going on in all four layers/quadrants.

On the server interface, each number represents a sound file, and the file's name and waveform diagram are visually placed adjacent to that number. Additionally, a small vertical fader is placed to the right of the waveform diagram (see Figure 4.3).

Figure 4.2. *4Quarters* server interface that all participants see projected onscreen.

When in play, each waveform diagram has a scrollbar, which becomes a significant feature when users want to coordinate simultaneously playing sounds. Synchronizing playback must be handled manually, requiring some skill and attention of performers if the sound files are groove-oriented with an explicit pulse and steady tempo. By design there is no tempo map or beat grid

that synchronizes playback, with the intent to engender musicianship and social cooperation to get the timing right.

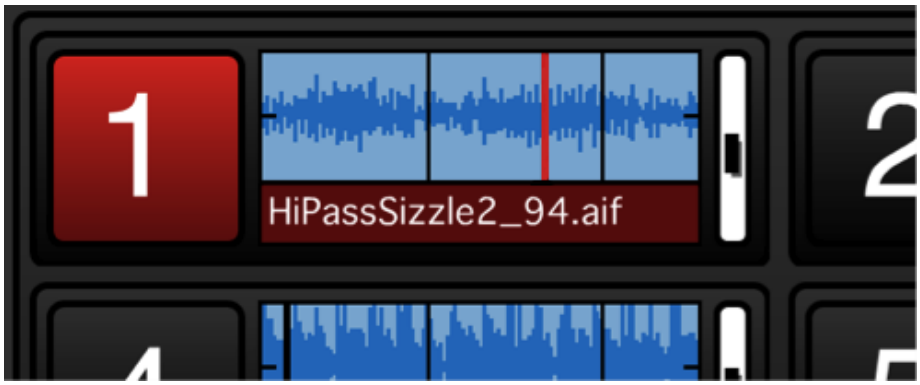

Figure 4.3. Close up of one sound file 'frame,' with waveform diagram, scrollbar (red), file name, and fader.

4.1.5 Audio Content

In terms of physical design, a stereo audio image comes from the server laptop or PC and is connected to speakers. Thus the phones do not physically produce sounds but serve only as controllers, and the requirement of external speakers limits the physical places where *4Quarters* may be performed. As a result, the *mobile* aspect of mobile phones is not leveraged to its greatest potential in this case. Concert halls, art galleries, living rooms, and classrooms are the most likely spaces for implementation, as they may have built-in audio systems, decent speakers, and video projectors or large screen televisions. Although the ability to have a phone act as the server is possible and certainly attractive, tethering the phones to a computer is currently a necessity for the visual component.[9]

The audio content is comprised of a series of pre-recorded sound files that are available for

[9] For an example of a work that allows multiple mobile devices to be tethered to one phone that acts as a server, see Marco Fabiani, Gaël Dubus, and Roberto Bresin, "MoodifierLive: Interactive and collaborative expressive music performance on mobile devices," in *Proceedings of the International Conference on New Interfaces for Musical Expression (NIME)*, Oslo, Norway, 2011, 116-119.

real-time playback, looping, and rapid file selection. Users are expected to create or curate their own sounds, although a set of example sounds are available for download alongside the application itself. While there are currently no presets that load bundled sound files into the *4Quarters* framework, this feature is in development and will become standard in the future.[10] Currently a user must drag and drop his/her own preselected audio files (either .AIFF or .WAV files) from the computer desktop into the *4Quarters* server application. This process takes place after the application is launched and devices and assignments are coordinated. Twelve sound files may be ready-at-hand for each of the four color-coded layers, and for each layer up to five sound banks of twelve files each are available to be called up and swapped in and out (labeled A-B-C-D-E).[11] Thus, 240 total sound files can be accommodated.

Because users frequently want to make things happen rather than sit back and listen, sound files that tend to best facilitate performance interaction are short in duration (one to four measures), loopable, and composed to fit 'hand to glove' with the audio files currently in other users' banks. Files could be individual samples of pitches of existing instruments, or they could be small snippets of one song, or they could be a collage of disparate sounds. The control is found in the choice of content on a systemic level, and then control is exerted in sound selection, rate of change to a new sound, number of simultaneously-playing sounds, sound volume, panning, and filtering. Every keypress (1 through 12) to select a file plays the chosen file from its beginning, meaning that one could rapidly hit the same key repeatedly to replay the beginning of a sample over and over. New features are in development to adjust the playback rate (including reversing the sound file or speeding up the playback), as well as the ability to loop a shorter selected segment within a file.

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[10] Originally I had wished to avoid bundling pre-composed sound files as a default presets so that the content would not interfere with the open nature of the instrument. In testing this software with users, however, it became clear that a default array of sound files would be necessary for a variety of reasons. These will be discussed in Chapter 5.

[11] A sound bank is a repository of several audio files placed in a specific location within the computer's RAM. When one switches from sound bank A to sound bank B, for example, the new set of audio files in bank B is loaded into the interface, replacing the files from bank A.

One possible format for composition for *4Quarters* is to have all banks from the four layers correspond in some fashion, with global formal structure characterized by parametric change from one bank to the next. This might be a way to suggest or imply formal guidelines for groups to use in improvising when selecting and synchronizing layers of sound.

4.1.6 Performance Assignments

When performing with *4Quarters*, there are three distinct roles within each layer/color that players may take: 1) file selection (including swapping sound banks), 2) volume/panning, and 3) EQ. The phone interface reflects these roles, with three corresponding pages of a custom TouchOSC layout form (see Figure 4.4).

Figure 4.4. Three TouchOSC layouts control sound file selection, volume/panning, and EQ.

The first role, file selection, allows a user to choose from a maximum of twelve files at any time and trigger playback. File selection and playback is controlled entirely by keypresses. As a default, pressing buttons triggers only one sound file at a time; but a poly feature may be engaged to allow multiple files to play at once. A stop button and loop button are additional controls, as well as buttons controlling sound bank selection.

Volume and panning are controlled on the second page of the TouchOSC layout. Here one

plays the role of mixer, adjusting the volume levels of the various sound files and their composite volume. Selecting a number and adjusting 'local volume' via fader can adjust the volume level for a specific sound file. The volume is tied to the specific sound file (and not simply the number associated with it). Since one number can be a placeholder for up to five different sound files (i.e. five sound banks each have a file mapped to '1'), the local volume will remain intact even if one changes away from a sound bank and then returns to it. The player can also opt to affect both panning and the master volume on the touch screen via slider, or toggle a button to use accelerometer data. When using the accelerometer, panning (X axis) and global volume (Y axis) data is routed to the *4Quarters* application, which in turn sends messages back to the phone to activate the sliders visually on the phone.

Basic EQ is controlled on the third page with an XY slider. The X axis affects the peak frequency and the Y axis is mapped onto the slope of the filter cutoff. There are six filters (with allpass as a default) for modifying timbre. Like volume, EQ can also be controlled via accelerometer data.

If desired, one player may take on all three roles of file selection, volume, and EQ, which results in a many-to-one complex mapping of sensors, or convergent technique.[12] With four colors, this means that a minimum of four players can operate all available control parameters, and a maximum of twelve can play. In the scenario of one player controlling all three sets of parameters, it can become difficult to swipe from one page to the next on the TouchOSC layout. Hence, on the first page (file selection) there are buttons that can switch on the tilt options for panning, volume, and EQ.

4.1.7 Instructions

It is clear that the current TouchOSC-based version of *4Quarters* could not reach the general public with any expectation of success. There are simply too many steps involved to get

[12] Andy Hunt and Marcelo M. Wanderley, "Mapping Performance Parameters to Synthesis Engines" *Organised Sound*, 7, no. 2 (2002): 97–108.

the phone and computer to synchronize prior to playing. That said, the process is not too difficult for interested and willing users such as university faculty and students, as is documented in Chapter 5.

Under the current format using TouchOSC, a user must complete the following steps to perform with *4Quarters*:

1) Download the *4Quarters* desktop application, which includes a custom TouchOSC layout file.
2) Ensure that both desktop computer and iTouch/iPhone are on the same wireless network.
3) Purchase, download, and open TouchOSC on the iPhone/iTouch.
4) Download TouchOSC Editor on the desktop/laptop computer.
5) Open the custom *4Quarters* TouchOSC layout within TouchOSC Editor.
6) Wirelessly port the custom *4Quarters* TouchOSC layout to mobile devices using the 'sync' option.
7) Open the *4Quarters* standalone desktop application.
8) Complete a 'handshake' between *4Quarters* and each TouchOSC device.
9) Load audio files into sound banks through dragging and dropping audio files from the desktop onto the bank buttons (A through E).

The bundle of files in the *4Quarters* download outlined in Step 1 includes the standalone application, a 'READ ME' file with documentation guiding users through the steps to purchase and download TouchOSC, and the custom layouts that will be uploaded to the phone. When launching the application, the first window that appears is a configuration page (see Figure 4.5), where the number of players and device assignments are specified.

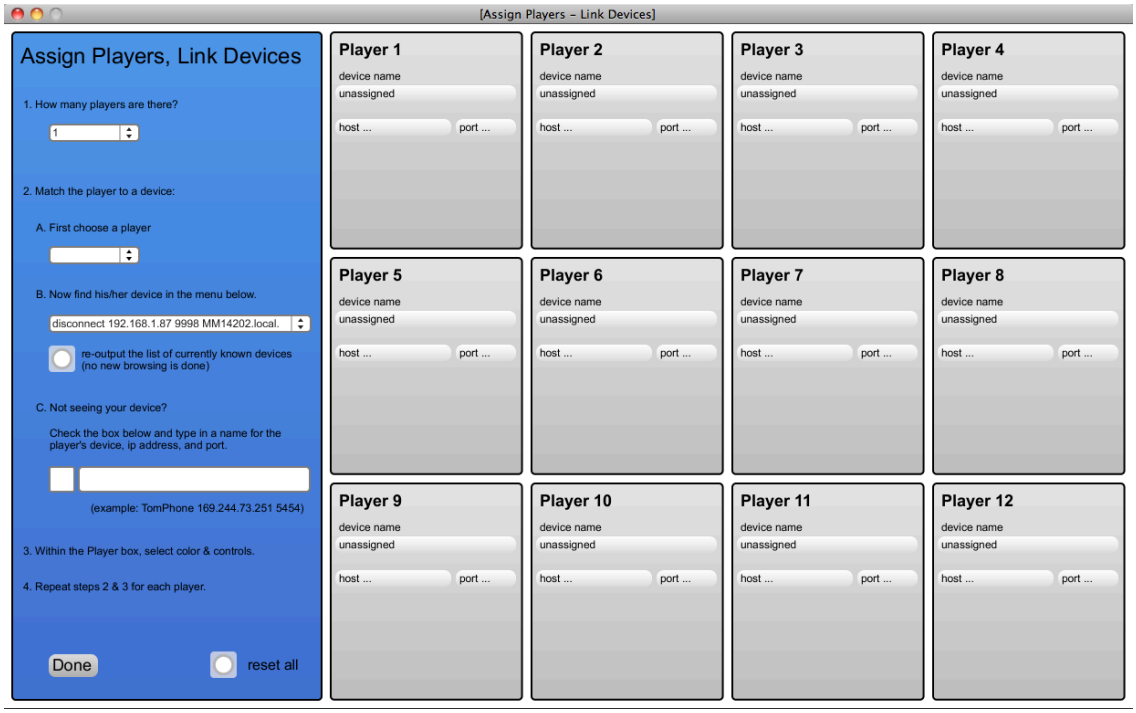

Figure 4.5. The setup screen allows one to select the number of players and create assignments.

When a specific device is assigned to a color (or team), the desktop/laptop server sends a message to provide haptic feedback to the phone – that is, a small vibration indicates that the computer has indeed been able to create a 'service' for the user's device. To complete the handshake, the user must confirm the assignment by selecting the appropriate service. When all players have gone through this process, the true confirmation of connectivity occurs when players are able to see their keypresses matched on the computer (or projected) screen.

A tab on the application menu is allocated for documentation, which links to a PDF file that outlines procedures for downloading TouchOSC and uploading the custom layouts to the iPhone/iTouch.

4.2 Presentation of compositional framework (prose walk-through of code)

4.2.1 Introduction

The architecture of *4Quarters* is presented here with programming as the central focus. The purpose of this section is not to give an explanation of all the software components that make up *4Quarters*, but to provide an overview for the programmer interested in collaborating or adding new features. Although the architecture is not simple enough to be self-explanatory, from the onset the software components (known as 'patches' in the authoring environmnent Max/MSP) have been designed to accommodate added functionality, more performance assignments, and more players if desired. Key design considerations and optimization strategies will be presented here. Main components will be presented along with a prose explanation of how they integrate, followed by more detailed commentary on each component.

4.2.2 Abstractions and Optimization

Much of the patching design relies on abstractions of one patch that can then be duplicated several times. For example, there are four main 'team' frames that are delineated by color, and within those frames are twelve numbers, each of which itself is an abstraction.[13] From a design perspective it was important to determine which parts of the framework would be best coded as separate abstraction files as opposed to subpatches. This approach to coding would allow one to make an adjustment to one file and have it be reflected in all instances quickly (as opposed to a similar approach: creating several iterations of a subpatch, but then needing to make the same adjustments repeatedly). As a result, expansion of players, teams, and available sound files can be added without need of a significant overhaul in patching. For example, although there are four main quadrants/layers, each with twelve sound file frames and five sound banks, one could reasonably expand to five or six 'teams' instead of four, or include

[13] In Max/MSP an abstraction is a separate file that can be embedded into a parent patch. Several instances of the same abstraction draw from one file.

fifteen sound file frames for each without need for a substantial architectural overhaul. In optimizing the design to control complexity, the disadvantage is that the more abstractions there are, the more difficult it is to make quick changes between components on the fly, since one is working with multiple files rather than one big file with active subpatches. I opted for the tradeoff of making quick cosmetic changes difficult to do in order to make it easier to implement global changes.

4.2.3 Overview of patch architecture

The central parent patch for this project is comprised of three main components: 1) an abstraction designated for handling network setup between devices and the computer; 2) the modules for each layer/quadrant—coded as four instances of one abstraction—; and 3) the audio output (see Figure 4.6.a). A screenshot of the actual patch is shown in Figure 4.6.b. An explanation of functions within each component follows.

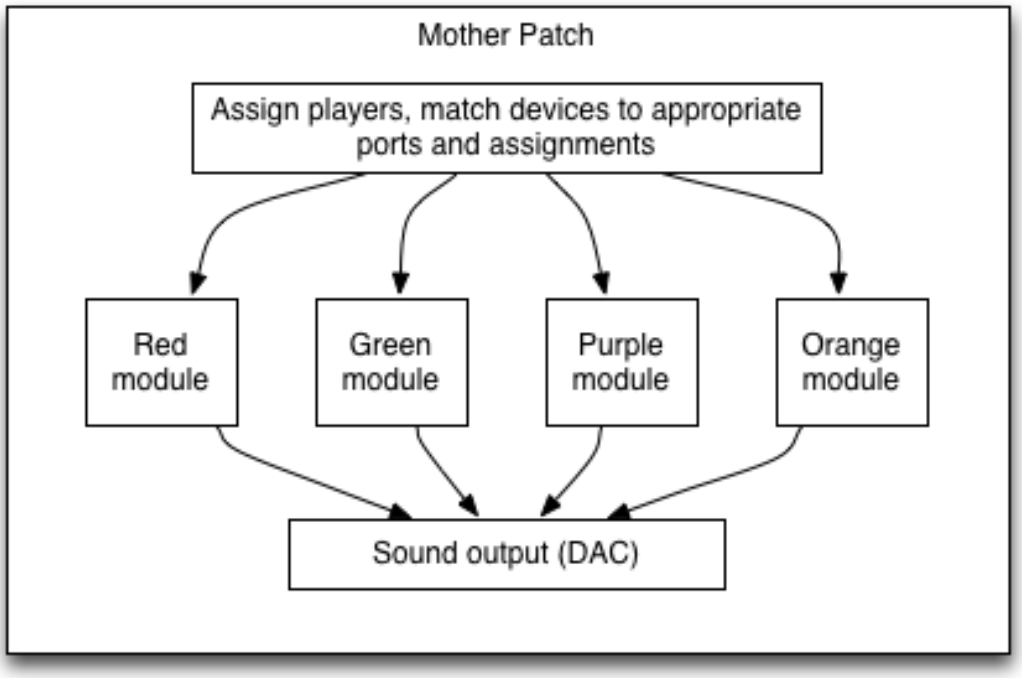

Figure 4.6.a. Representation of the mother patch architecture

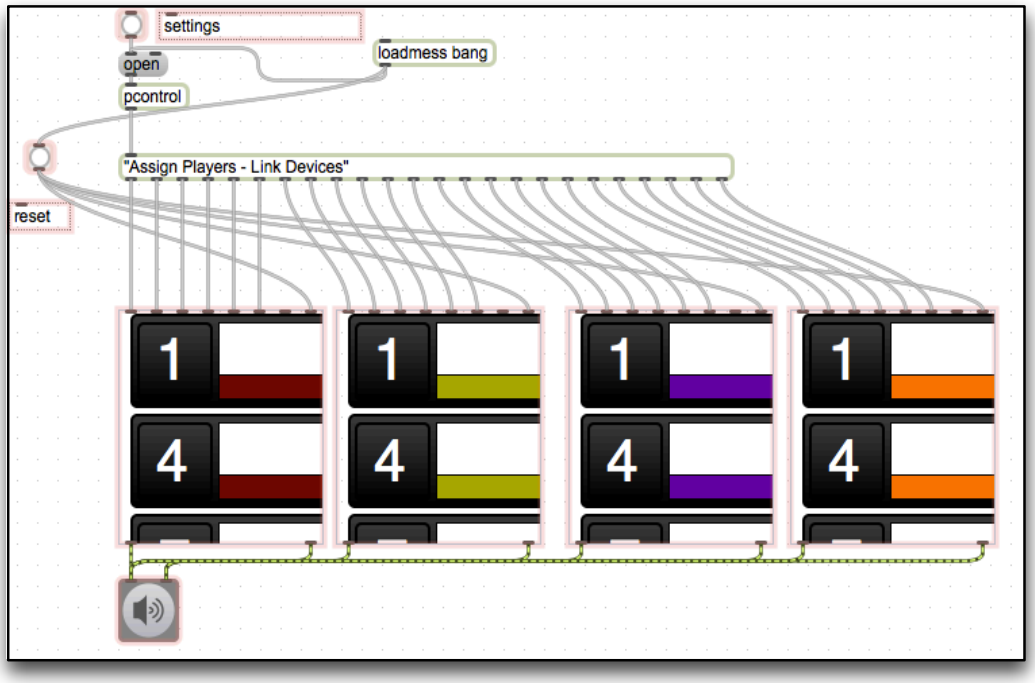

Figure 4.6.b. View of the central components of the mother patch in 'edit mode' within the *4Quarters* application, authored in Max/MSP.

4.2.4 Assign Players – Link Devices

During performance setup and configuration, each device is configured one at a time. This takes place within the 'Assign players – Link Devices' abstraction. With a maximum of twelve iPhone/iTouch devices that can be linked to the patch, there are twelve instances of a 'config' patch embedded within this abstraction (see Figure 4.7). At present there is no way to automate the configuration process beyond the computer recognizing devices present within the local area network.[14] The handshake process is completed when *4Quarters* recognizes the device, the device is assigned to a player role, and the user confirms the assignment from within TouchOSC

[14] I use Mattijs Kneppers's 'OSC Java for Max' external objects, which creates two advantages not native to Max/MSP: 1) his OscBrowse object allows Max to detect all OSC-enabled devices within a local area network; 2) the OscService object allows Max to generate a configured service with a specified port and host IP address that a user can select by pushing one button, removing the need to enter in ports and IP addresses manually. Mattijs Kneppers, "OSC Java Objects For Max," Sourceforge, updated 2012, accessed January 31, 2012, http://sourceforge.net/projects/oscjavaformax/files/.

on his/her device. IP addresses and ports can be manually entered on both the client and server sides if *4Quarters* cannot identify a device on the network.

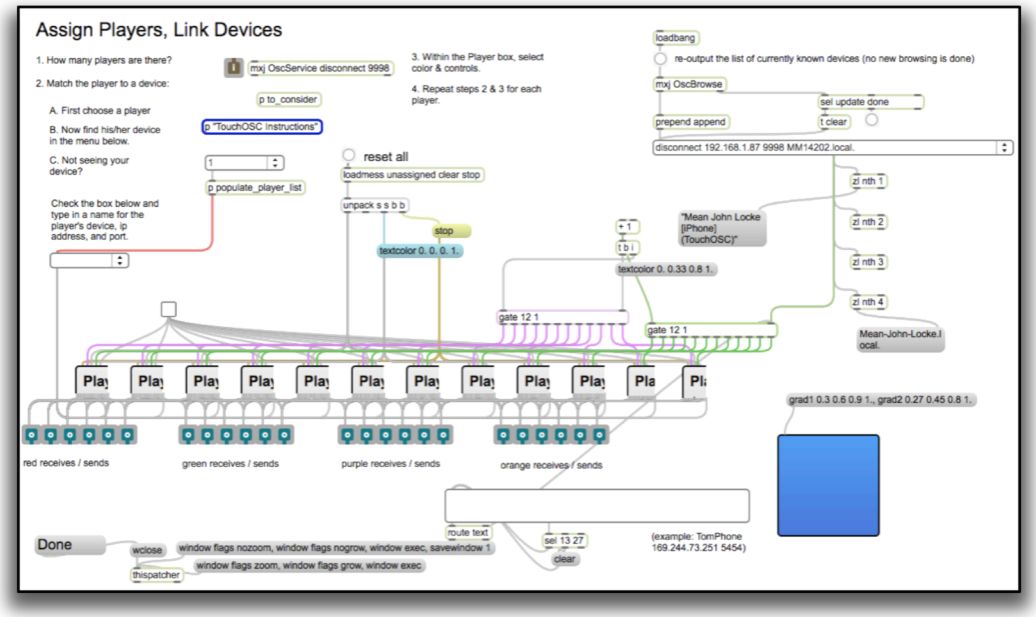

Figure 4.7. Screenshot of 'Assign Players - Link Devices' patch in 'edit mode' within *4Quarters*.

4.2.5 Main Modules

The main module is where the majority of the processing takes place during performance. Each instance of these modules is delineated by color, as specified by a simple argument (red, green, purple, orange, etc.). Internally, the color becomes a keyword used to define routings from within the module, ensuring that routing assignments stay separate between one abstraction and the other (see Figure 3b; purple patch cords indicate a routing line that is dependent on this color naming system). This is particularly important in order to allow lower level abstractions, which are separate files—not subpatches— to communicate with one another.[15]

[15] As Max/MSP—the programming language *4Quarters* was written in as explained in 4.1.3—typically features patch cords that are visual representations of wires, one can also use 'wireless'

Since there are three main roles—and corresponding pages—on the phone's TouchOSC layout, these areas of activity are kept separate but nested within this module (see Figures 4.8.a & 4.8.b. Colors of subpatches are used for convenience to show the relationship between Figures 4.8.a & 4.8.b). The subpatches with yellow, red, and blue outlines in the two figures indicate the areas in which OSC messages are received and sent.

Once ports are defined between devices and the server, all incoming and outgoing data between the *4Quarters* application and phones are sent and received within each of these subpatches within the module. Each OSC patch carries out three primary tasks: first, the incoming data from the phones must be routed onward to internal audio commands; second, ports receiving incoming interface commands are routed to the abstraction designated for the visual interface that appears on the computer; third, incoming data initiates commands to be sent back to the phone to create visual feedback its TouchOSC layout. For instance, if a button is pressed activating the accelerometer to drive the volume faders, *4Quarters* pushes the accelerometer data to affect the actual volume level, but will show this visually on two separate faders: one on the computer's screen, and the other on the phone's TouchOSC layout.

Audio files are loaded on the computer through drag-and-drop windows from within the visual interface abstraction, and the filepath data are ported to the subpatch where files are called and stored (see the green box 'Sound file storage and internal commands for playback' in Figure 3a). Conversely, any change in playback initiated in the subpatch—file selection, bank selection, playing and stopping files, looping, etc.—must be reflected visually on the interface, meaning that a two-way communication exists between these two areas. The main visual interface for each of the four layers is comprised of an abstraction with twelve instances, one for each sound file, along with global volume and EQ controls.

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routing to avoid visual clutter for complex patch jobs. It is a useful feature when creating routings between separate files loaded as abstractions within a parent patch.

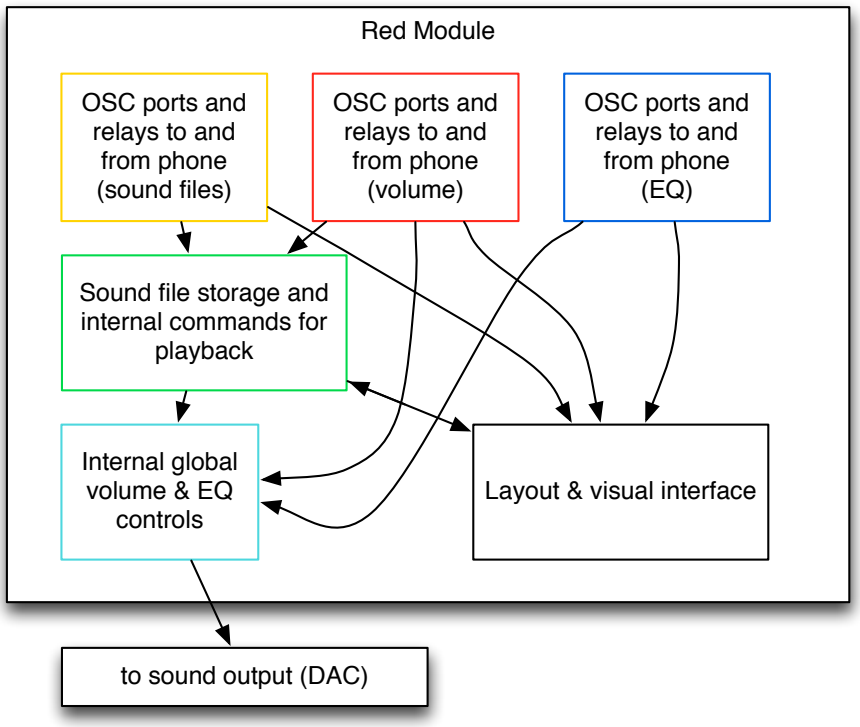

Figure 4.8.a. Conceptual diagram of internal components of the main server Max patch.

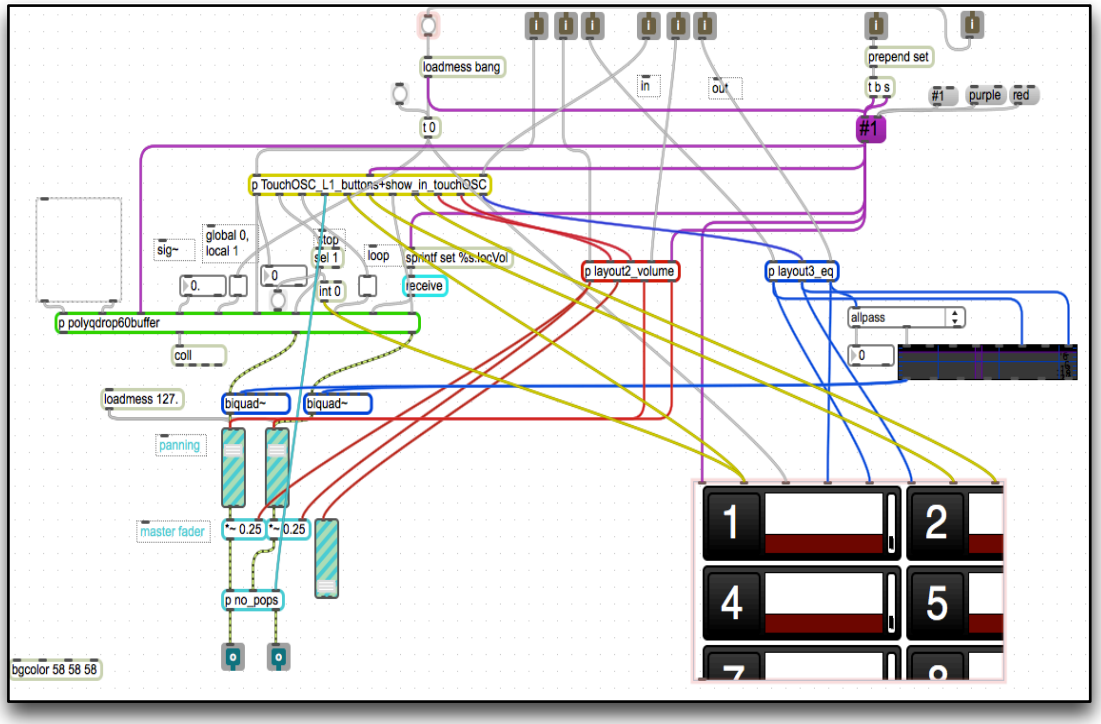

Figure 4.8.b Main server patch with subpatches, viewed in 'edit mode' in Max/MSP.

The sound file storage patch currently allows 60 audio files to be imported into RAM for each of the four layers, totaling 240 files. For optimal performance each of these files should be five megabytes or less in size. The heart of this subpatch is an MSP poly~ object which holds 60 instances of the same abstraction. The subpatch is designed to route commands for any of the 60 instances depending on which sound bank is selected. Volume for each audio file instance can be set and retained even if a user toggles back and forth between sound banks.

4.2.6 Future developments

In its current state *4Quarters* is functional but not fully optimized for the scenarios for which it was conceived. In general, the *4Quarters* configuration and setup process is an area that takes far too long and is much too complicated for the lay user, and ought to be improved in future releases. There are precedents of participative mobile music pieces that draw user feedback from phones through integrating web browsers and OSC.[16] The advantage of this approach is that it does not require a user to download an application to his/her device. Still, it remains to be seen how well a variety of phones with different accelerometers can be accessed and calibrated to yield the same range of movement for gesture-based parameters. In changing to a browser-based interface, therein lies a possibility for automating the configuration process and reducing setup time. Rather than users operating within the TouchOSC interface which requires exposure to ports and IP addresses, the user would initiate the handshake by pointing to a website—a far more familiar process—followed by selecting buttons on a webpage for further configuration.

4.3 Presentation of Code

The entire software component of *4Quarters* is available as supplemental material to this written dissertation. It is accessible as a downloadable standalone application, stored as a .dmg

[16] Allison, "Web Based Control of Mobile Ensembles"; Oh and Wang, "Audience-Participation Techniques."

file, for Mac OS 10.4-7. Also included are 184 pre-composed sound files are stored on this .dmg file, along with the accompanying TouchOSC layout. It may be accessed at http://nb23.com/Diss/4Quarters%201.1.dmg.

CHAPTER 5. DOCUMENTATION

For any software-based project that is intended for broad use, a designer's perspective alone cannot ensure that the software will be received the way it was intended. Test groups can provide valuable feedback in shaping how a project might take form, illuminating design oversights and exposing what is effective versus what is not. The purpose of this chapter is to provide documentation on the ways that *4Quarters* has been received thus far when used by others. I will document installations, my experiences in sharing the standalone with collaborators, and user response in controlled test settings.

5.1 Performances and Compositions

5.1.1 Introduction

4Quarters has been presented as an installation rather than a concert performance thus far. It was premiered at the 2012 Conference for the Society of Electro-Acoustic Music in the United States (SEAMUS), with a paper presentation at the 1st Symposium on Laptop Ensembles and Orchestras (SLEO). *4Quarters* has been since shown at the Del Mar College Composition Symposium in Corpus Christi, TX, and will be presented as an installation at the 2013 New York City Electroacoustic Music Festival (NYCEMF). Under the direction of Timothy Edwards, the laptop ensemble at Columbia College Chicago plans to use *4Quarters* to perform a structured improvisation for an end-of-semester concert in Spring 2013. In this section I will provide a synopsis of each presentation, and detail highlights as well as difficulties encountered in these performance scenarios. For those presentations scheduled for the future, plans and strategies will be outlined.

5.1.2 *4Quarters* at SEAMUS Conference 2012

With the generous help of several SEAMUS participants lending devices, twelve iTouch/iPhones with TouchOSC were gathered for the installation presented at SEAMUS Conference 2012 at Lawrence University in Appleton, Wisconsin. Participants who lended devices downloaded the custom *4Quarters* TouchOSC layout prior to the conference, and I configured the phones manually. This marked the first time that twelve participants—the maximum number of performers allotted in the current *4Quarters* design—were able to play together. With conference guests drifting in and out of the room at unpredictable times, it was not expected that a concert-standard performance would take place. Most of the time participants were exploring the capabilities of the instrument as well as discovering what sounds were loaded into the various sound banks. It quickly became apparent that a leader or prepared score would be needed in order to generate any sort of coordinated effort. If there were a group of friends or colleagues who knew one another, they were far more likely to communicate verbally with one another to create an ad hoc performance, but these moments were intermittent. Over the course of the conference several participants visited the installation repeatedly to acclimate themselves with the setup and provide suggestions. The overall experience highlighted the reality that *4Quarters* is an instrument, and the mastery of it is subject to the same limitations and time requirements as other instruments. Proficiency and coordinated ensemble performance would need to take more time than a brief exposure at a conference.

Highlights

User response was largely positive, and there were no major software failures that sidelined the installation. Several people cited the interface as intuitive and easy to navigate, drawing attention to how it is clearly designed to allow multiple people to work together to perform. A handful of participants were very enthusiastic about the design, the extent of

Max/MSP creativity, and the broad-based appeal this instrument could generate. One participant suggested that *4Quarters* might be particularly useful in hospitals, where patients may have use of their hands, but may be otherwise limited in movement. In conversation, composer/instrument inventor Jesse Allison also introduced his forthcoming work on mobile web browser-based OSC communication via Javascript, an exciting step in the direction of accessing *4Quarters* without regard to mobile phone hardware and operating system platforms.

Difficulties

In spite of the wi-fi access made available for the conference, TouchOSC was not able to send and receive data on the provided network. After attempts to set up devices, it became apparent that the network provided by SEAMUS had a firewall of some kind that prevented connectivity. TouchOSC designer Rob Fischer warns users of this limitation at hexler.net:

> Please note that any kind of firewall or security software running on your computer can be an absolute showstopper when it comes to network communications.[1]

As a workaround, initiating a wireless LAN from the laptop allowed TouchOSC to connect successfully. This was the network used throughout the conference.

Although I could configure each mobile device manually prior to visitors dropping in, it was clear that even among a specialized community such as SEAMUS that many people were unfamiliar with network configuration, ports, and OSC as it pertains to wireless devices. The 'handshake' process clearly needed improvement, especially if *4Quarters* is to target lay musicians and non-specialists.

In the process of multiple devices transmitting OSC messages, it became clear that the system can become taxed and shows signs of glitches, latency issues, and dropped packets of information. It was not clear whether this was due to low processing power of the computer, RAM, network limitations, or OSC. Also, if a bank of large sound files is called up, that

[1] Rob Fischer, "Documentation | TouchOSC | OSC with PureData," *hexler.net*, accessed February 14, 2013, http://hexler.net/docs/touchosc-getting-started-osc.

transition can freeze the entire computer screen and create confusion for all players, especially if they are unaware of another performer's action to switch sound banks. This problem can be circumvented with increased RAM capacity on the desktop server, or by loading sound files that do not exceed 10 to 15 seconds.

5.1.3 *4Quarters* at SLEO 2012

Because the SLEO symposium was largely geared toward laptop ensembles and performance groups comprised of dedicated students with above-average music and computer programming skills, I solicited colleagues there to use *4Quarters* in their own classroom settings, working with ensembles to generate their own performances. Deploying *4Quarters* as a standalone application to colleagues would increase exposure to more users and allow functionality issues to surface.

In this presentation of *4Quarters* I stated the intention to cater to a broader public and leverage mobile phone ubiquity. The software was thus framed as a work in progress, with the limitations of the current configuration process being a potential area of development.

Highlights

The initial response from a small number of participants was very positive, and they expressed either a desire to try *4Quarters* or to stay in touch as the 'zeroconf'—the shortened term used for zero configuration networking—process evolves.[2] Those interested in implementing *4Quarters* in the classroom ranged from K-12 to university settings.

[2] Zero configuration networking is a set of techniques that automatically creates a usable network between devices without manual operator intervention. This is not a feature supported natively by Max/MSP or TouchOSC.

Difficulties

After deploying *4Quarters* to several interested parties, only one group so far—Timothy Edwards's ensemble at Columbia College Chicago—has continued to explore its use in earnest and remain in correspondence. In using the initial standalone application, Edwards found two significant problems: first, his group was unable to connect their mobile devices to the desktop successfully; second, when loading sound files, they had no way to know whether the files had loaded properly. The ability to call up banks of sound files was only possible via a connected mobile phone. For the configuration process, TouchOSC permits one to stipulate ports by manually typing them, but in an effort to keep any possibly confusing information 'under the hood,' the server-side configuration patch did not include the ports. This meant that from a user perspective that it was impossible to know which ports were designated to specific assignments. Both problems were addressed and solved in an updated version of the application.

5.1.4 *4Quarters* at Del Mar College Composition Symposium

This performance marked the first attempt to present *4Quarters* within a concert setting. The objective was to have Del Mar College students explore the instrument live as an improvisation, programmed between other rehearsed chamber pieces. Students at Del Mar College downloaded TouchOSC and were first exposed to the software during a brief rehearsal and sound check the day of the concert. From the standpoint of the programmer, the novelty of the experience would be sufficiently interesting to the audience to warrant performance, notwithstanding the lack of rehearsal time. Due to in-concert technical difficulties with the audio, the realization of this improvisation did not occur.

Highlights

Student performers were very quick to learn the *4Quarters* interface and were able to operate it adeptly in spite of their brief exposure to the software. They exhibited enthusiasm

and willingness to participate in spite of having very little experience with software instruments or mobile phone music.

Difficulties

The performance was not carried out due to audio interface difficulties. It required the application to be shut down and restarted. At this point there were no presets that could allow sound files to be added via automation, and each device also needed to be manually configured. When using a LAN with 169.xxx.xxx.xxx addresses—as was the case here—, Apple's bonjour IP detection service is inoperable, meaning that each student needed to type in IP addresses and ports. The time required for rebooting the setup rendered it impractical to troubleshoot in front of an audience.

In addition to the startup problems, this performance attempt highlighted a constraint throughout the process of design: the lack of resources to fund the purchase of twelve iTouch devices, which has in turn limited the possibilities to form a standing ensemble dedicated to developing a performance practice and pieces for *4Quarters*. The number of participants has been a direct function of how many people within a production happen to have iPhone/iTouch devices and are willing to purchase TouchOSC. This can be formed ad hoc locally, but the time of this performance documentation and setup was beyond the expertise of local faculty, and bringing a travelling group of lower division undergraduates to Del Mar College for the concert—I currently teach at a community college—was not feasible for a variety of reasons.

5.1.5 Future Performances and Plans

In spite of several obstacles encountered along the way, there are encouraging factors that create a promising outlook for future performances. Timothy Edwards's laptop ensemble at Columbia College Chicago continues to explore *4Quarters* as a performance instrument. They are choosing to use it for five performers, each with his/her own laptop, mobile phone, and mono speaker. This is not the configuration for which *4Quarters* was designed, but having a

group holding regular rehearsals will provide valuable insight about practical performance practice. For the upcoming NYCEMF installation in Spring 2013, I aim to compose a piece for *4Quarters* with very basic written instructions, designed for an ad hoc performance group to be assembled over the course of the festival and perform the piece with few rehearsals. I will also continue to explore alternatives to TouchOSC. HTML5-based programming languages Socket.io and Node.js may allow browser-based interfaces to transmit OSC messages. Though it is unlikely that this change in protocol and *4Quarters* architecture will be ready in time for NYCEMF, these languages are gaining attraction because they permit user input to be conveyed cross-platform to servers in real time without the need to download dedicated apps. The goals of providing cross-platform access for a wide variety of mobile devices coupled with reduced configuration time may indeed become viable in the near future.

With the experience of several installations and having observed *4Quarters* primarily in casual settings, I will likely turn attention toward composing traditional pieces with specific timelines for dedicated performers, and scores to follow. As an instrument still relatively in flux, building a dedicated community of composers and performers will help solidify how *4Quarters* can be used. Of particular interest, composition can take place in the preparation of sound files, or also in the performance domain, with improvisation or loosely structured formal instructions guiding performance. I am personally interested in writing compositions in which multiple composers agree upon a few parameters prior to performance (such as certain formal actions at marked times, digressions and unisons, tonal areas, timbral groupings), but bring their own files into the *4Quarters* environment for group improvisation, rehearsal, and performance.

5.2 Surveys and Reactions of Participants

5.2.1 Introduction

In addition to presenting *4Quarters* at conferences, symposiums, and festivals, the software has also been presented to test groups to evaluate how the software is interpreted and

use by a variety of subjects. Here I will document the goals of the testing, the methodology used for the study, and the results.

5.2.2 Goals

The purpose of this study session was to determine how participants use *4Quarters* when introduced to the software. User feedback from a wide range of subjects would provide an indication of accessibility to *4Quarters* while also giving a general sense of how mobile phone music is presently perceived. For musicians, is the instrument sufficiently expressive to permit an upward pathway to virtuosity? What features do musicians find lacking, and what existing features are most compelling? Does the interface make use of screen space efficiently? For non-musicians, is *4Quarters* intuitive and easy to use? Does *4Quarters* allow users to feel musical, even if they do not consider themselves musicians?

As the *4Quarters* application is viewed as being in its infancy, a study in user response at this stage might provide valuable insight as to how to direct future development and features so that it might be streamlined for public use. Due to limitations of funding, the inability to compensate participants financially, and the aforementioned limitations in the *4Quarters* configuration process, a far-reaching study with a high volume of participants would be impractical. The initial aim was to involve one hundred participants in study sessions. Anticipating that young adults might be the most likely demographic to have an affinity for this form of music-making, the hope at this stage of *4Quarters* development was to gain robust representation from undergraduate music students in particular. Participation from a wider range of age demographics and musical experience was also desirable.

5.2.3 Method

Following IRB-approved procedures, participants were solicited via email advertisement and word-of-mouth to meet for hour-long test sessions over the course of three weeks. Participants were informed at the beginning of the session of their rights as subjects, any

possible risks involved, the expected time commitment, measures taken to ensure privacy, and the user's right to opt out of participation at any time.

Test groups were assembled over the course of two weeks to demonstrate the software and allow users to interact with one another and play with *4Quarters*. Sessions took place in a music classroom with wall-mounted stereo speakers and screen projection displaying the *4Quarters* interface. The session leader operated a laptop running the *4Quarters* server application, while participants were provided iPhones/iTouches to control the TouchOSC custom layouts. Volunteers provided iPhones and iTouches to allow multiple devices for each session. In situations where the number of participants in a session exceeded the number of available devices, users took turns holding and operating the mobile devices.

Sessions lasted approximately 45 minutes, and participants were asked to complete a 24-question survey. For the sake of expediency, users were guided through the 'handshake' process between *4Quarters* and the TouchOSC layouts, and were provided a cursory explanation of how the laptop and phones communicate over a wi-fi network, the role of ports and IP addresses, and the types of data transmitted between devices. Once all devices were connected, the session leader outlined the various features of *4Quarters* during the session, guiding users to learn each control parameter. Users were also encouraged to improvise and perform together.

5.2.4 Results

At the time of this writing twenty-eight participants took part in the study sessions, roughly only one quarter of the study goal. The sample size is far too small to be able to come to any definite conclusions, but the results thus far do provide some indications about the use of the software, and familiarity with mobile phone music. A few statistics should give a sense of the respondent pool and the key questions:

- 75 percent male, 25 percent female
- 82 percent aged twenty-five or younger, 18 percent aged over thirty-five

- 72 percent had never used mobile phones to make music
- 88 percent are current music students; 84 percent of all participants have been members of a performing music ensemble; 64 percent have had formal instrumental training.
- 72 percent said that *4Quarters* was easy to navigate (56 percent "easy," 16 percent "very easy"); 24 percent said "neutral"; 4 percent said "difficult."
- 44 percent said the best part of the *4Quarters* experience was discovering how to influence sounds; 24 percent said making music; 20 percent said working with others; 4 percent said "figuring out how to use the interface"; 8 percent marked "other"
- 60 percent said the most confusing part of the *4Quarters* experience was "figuring out how to use the interface"; 12 percent said "discovering how to influence sounds"; 12 percent said it was not confusing; 4 percent said "working with others"; 12 percent marked "other"
- 64 percent reported being able to see how their input was displayed visually without any problems; 64 percent said the visual display on the screen was intuitive; 44 percent said it was helpful to see what others were doing; 0 percent said that it was difficult to negotiate looking at both the phone and also the bigger display.
- 80 percent liked the ability to control multiple parameters at once
- 44 percent noticed glitches; 20 percent noted that pushing a button occasionally did not effect anything; 16 percent reported intermittent latency between a keypress and its corresponding visual result
- 36 percent felt like they were able to make interesting music during the test session; 40 percent felt they could if given more performance time; 12 percent expressed interest in performing a composition with more structure; 8 percent felt that they could make music with extended practice; 0 percent reported that it was too unstructured; 0 percent felt they were "just making noise"
- 96 percent felt *4Quarters* had "a lot of expressive capabilities"
- 72 percent felt a sense of cooperation when performing with others; 4 percent did not; 24 percent marked "not applicable" because he/she played *4Quarters* alone

Due to the short time-span of the sessions and the limited exposure to the software, the session evolved to become a study of initial impressions and first reactions to *4Quarters*. For the majority of participants involved in the study, the experience of mobile phone music was entirely new, and that novelty greatly affected the nature of the study session and was reflected

in the tone of the feedback. Jeremiah Gray, an undergraduate music major participating in the survey, captured the general spirit observed:

> It seems a bit overwhelming to be able to actually produce complex music as one might desire with the restrictions of using just a small phone. Though, I believe that with enough time and practice, it would become easier.[3]

A handful of students were willing to come to multiple test sessions, and expressed a desire to use the software repeatedly to learn the instrument and gain proficiency. Subsequently a smaller group of committed students met on a regular basis and formed an ad hoc ensemble to rehearse and explore coordinated performance and possibly develop compositions.

Surprisingly, the majority did not want a goal or structure. Many music students liked the possibility of composing and performing pieces on their own, but did not feel that the instrument should impose a structure or goal. Undergraduate music student Zachary Skovold wrote:

> I really like the "sandboxyness" of this app. It is something I enjoy the most. However, I think that to some non-musicians, having a goal or set of things to accomplish would be more desirable. Having a goal or performance score would have more mass appeal.[4]

Notwithstanding the potential for formal compositions and rehearsed performances, several students seemed more enthusiastic about the potential for group improvisation as a self-contained activity. Undergraduate music student Alec Cannon said:

> I think it could be used more for the enjoyment of making music with friends where you make up the sounds and rhythms as a group as opposed to playing music that is already written out.[5]

Still, most agreed that the instrument is flexible enough to accommodate either improvisation or dedicated compositions.

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[3] Jeremiah Gray, survey response. Quoted with permission.
[4] Zachary Skovold, survey response. Quoted with permission.
[5] Alec Cannon, survey response. Quoted with permission.

72 percent of participants reported that they felt a sense of cooperation and community while performing.[6] When asked to specify how or when this occurred, Zach Skovold noted, "It immediately encourages cooperation. When I was trying to test certain features, I had to coordinate with my partner."[7] In response to the same question, Jeremiah Gray wrote,

> It was fun when you could here and see what the other person was doing and to be able to adjust your own musical sounds and expressions accordingly to create an altogether cohesive sound. Actually looks like a hell of a lot of fun to be had.[8]

Undergraduate music student Kianna Reusga added,

> The entire time you are interacting with the system, you are interacting with the other users as well. In a way you have to trust, or have confidence in the other users that they will have the right timing.[9]

In order to help users synchronize, one useful suggestion was to include a screen-based metronome. This was easily added over the course of the study sessions, and proved to be helpful. An additional suggestion was to create a master conductor role who could send messages to the projected screen for everyone to view. Undergraduate music student Nate Lee wrote:

> Maybe the conductor should have the ability to force beat-locking. It seems that currently users are able to create things asynchronously. It might not even be a bad idea to cause new loops to wait until 'beat 1', or loop start before they start playing. Or maybe give the user the option to turn on/off the ability for the loops they select to wait for beat 1. The ability of the conductor to solo users might be cool also.[10]

Though many liked the lack of a quantized beat grid—as it forced performers to cooperate and communicate to get in sync—, most were in favor of this feature as an option.

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[6] Nearly one quarter of the participants only performed alone, as they were either the only ones present for a test session, or there was a lack of devices to divvy up between participants. One person who did perform with others reported they did not feel a sense of cooperation when performing.
[7] Zachary Skovold, survey response. Quoted with permission.
[8] Jeremiah Gray, survey response. Quoted with permission.
[9] Kianna Reusga, survey response. Quoted with permission.
[10] Nate Lee, survey response. Quoted with permission.

Many people reported that the best part of the phone interface was the ability to control multiple parameters at once. This is similar to Tanaka's discussion about affordances and complex mappings, where the combination of multiple mappings to control one sonic event enabled a performer to feel a greater sense of agency with a given digital musical instrument.[11] Some music students expressed an interest in having a richer suite of options for expression. There was a desire to be able to use the phone to play dedicated pitches and control the timbre of those pitches simultaneously through gesture. The idea was not to eradicate the sample-based format, but to have options to swap out a quadrant of samples on the main interface for a synthesizer. In the future this expansion to different kinds of complex mappings will be an area of development. In *4Quarters*, classic multimodal interaction—that is, a single gesture being captured by multiple sensing modes—is being leveraged only by two kinds of sensors at the moment (touch and accelerometer).

Several music students requested the ability to play discrete notes, scales, and chords. In response, over the course of the study sessions I generated several scale options with different instruments, a bank of strings arrayed in a chord progression with chorale-style voice leading, along with a bank of individual drum samples. These immediately became popular bank choices, though players frequently tired of playing individual drum samples over a sustained period of time. One participant suggested a workaround: record a performer's keypresses within a certain timeframe, and then loop the sequence via automated playback. Others expressed a desire for MIDI connectivity between *4Quarters* and other digital audio workstations. *4Quarters* would function as a central hub for coordinated performance, but the bridge to other applications would permit access to virtual instruments and synthesizers.

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[11] Tanaka, "Mapping Out Instruments, Affordances, and Mobiles," 89-90. Tanaka proposed a tri-partite mapping structure of 1) binary mapping, 2) basic parameter mapping(s), and 3) expressive mapping(s). This structure can be applied to the *4Quarters* user who elects to control all three available player roles. Within *4Quarters* a single performer can control 1) sound on/off (binary), 2) sound selection and volume (basic), and 3) EQ (expressive).

In contrast to those wanting more upward mobility and expressive capabilities, for some lay musicians the novelty of using the phone musically was rewarding by itself. A simple interface was viewed as a desirable quality instead of a limiting factor. Matt Cannon, a participant who does not consider himself a musician, said, "For someone like me, who is not especially 'tech savvy,' I felt like *4Quarters* allowed me to do a lot more than I could have imagined."[12] Going forward, catering to both non-musicians and musicians may be a matter of they types of banks made available for selection. Scales and drum kits parsed into individual attacks may appeal to trained musicians, but non-musicians may more comfortable with drum loops and pre-composed melodies that decrease the rate of keypresses required to sustain continuous sound.

5.3 Conclusion

5.3.1 *4Quarters*, evaluated

In examining the results of the *4Quarters* test sessions, the most intriguing result was how few people had used mobile phones for the purpose of musical creation. 72 percent of all participants had never used their mobile phones to make music. When narrowing the field to music students, the number was 70 percent. Perhaps more telling, 63 percent of music students under the age of 25 had never used mobile phones to make music prior to the *4Quarters* test session.[13] In other words, even within the demographic most likely to have experience with mobile music-making, this form of musical engagement is still new to most. It became clear over the course of test sessions that the software presented was a novelty.

At the same time, with very few exceptions, participants demonstrated a clear enthusiasm for the ability to make computer-based music live, and for the experience to be

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[12] Matt Cannon, survey response. Quoted with permission.
[13] This number may very well be a result of polling community college undergraduate students. At Moorpark College there is not a culture of interactive media, nor any courses dedicated to learning coding languages for artistic purposes. On campuses with undergraduate or graduate digital media arts programs, the numbers would likely be different.

collaborative. The general sentiment was that this format for exploring sounds was fundamentally different from using desktop DAWs, and this difference was an exciting prospect for many. In addition to providing useful recommendations to improve the interface and instrumental capabilities, respondents had numerous suggestions for practical uses for *4Quarters*, including the following:

- Permitting audiences to play along with an onstage band, each participant contributing to an ambient musical texture that forms a supportive background to the band's music
- Leveraging *4Quarters* for classroom use, teaching musical concepts (e.g. roman numerals or form) by live non-linear playback
- Recording artists providing 'unlocked' session tracks with stems, encouraging fans not only to generate remixes but also to perform them live
- Establishing freestyle jams in club settings for multiple DJs, each performing with their own set of samples based on mutually-agreed criteria such as BPM and key

Users also recognized that the setup experience would need to become faster, easier, and more stable before it is ready for the general public. Until this aspect can be dramatically streamlined, one cannot begin to speculate on the adoption of *4Quarters* as an instrument for the masses. Still, there are new tools for making the connection process easier—Node.js and Socket.io are a few—, and these tools may eliminate the need for a downloadable app on the phone, thereby opening up the *4Quarters* experience to a greater variety of mobile devices.

In conjecturing future developments of *4Quarters*, here is a consolidated list of the features that I plan to add:

- Seamless connection from a variety of smartphone handsets to the *4Quarters* desktop application via a web-browser, possibly implementing Node.js and Socket.io or similar protocols
- Increased sophistication in mapping gestural data to multiply the number of kinetic movements that can affect sound, and increase the ways sound can be manipulated
- An online repository or community space dedicated to the exchange of sound banks written specifically for *4Quarters*

- Recording capabilities
- Tutorials for first-time users
- Presets that automate the sound-file loading process, and permit customizable presets that allow users to automate the setup process for a particular array of sound banks or sound files.
- An option for a beat grid that quantizes user keypresses to ensure synchronized sound file triggers
- Added functionality to permit integrated visual effects and tools for video improvisation
- The addition of an optional conductor role, which would allow a leader to send messages to other performers or coordinate ensemble synchronicity and formal cues

5.3.2 *4Quarters* in the Context of Mobile Music-making

In the first three chapters of this dissertation I focused primarily on the background and context of mobile phone music-making. With *4Quarters* now introduced, it can be placed within that scope. *4Quarters* is not a standard mobile phone instrument when compared to most others, which use the hardware handheld device and the corresponding software as a standalone instrument. Because *4Quarters* departs from this model by instead treating the phone as a controller, the mobility factor—being able to perform on the go in a variety of physical settings—is severely constrained. A second approach to design—the collaborative aspect—sets *4Quarters* apart from most other mobile phone instruments. Though sharing content or playing in groups is certainly possible with many other mobile phone instruments, it is not suggested the same way that collaborative performance is implied in the *4Quarters* interface and design. That said, instances of mobile phone music-making that are situated toward audience participation in concert settings share a likeness in concept: the mobile phone is intended to allow novice musicians to have a direct impact on the musical outcome.

When comparing what *4Quarters* can and cannot do with related projects, two have strong similarities: Knowles and Paek's *3001: Collaborative Musical Gameplay*, and Smule's

MadPad.[14] Although *4Quarters* does not have the same goal-oriented approach found in Knowles and Paek's *3001: Collaborative Musical Gameplay*, this work has strong overlap in terms of number of participants and the physical setting required to play. Like *4Quarters*, Knowles and Paek's work uses a central screen that all viewers use to assert and validate their musical influence. *'3001'* also makes no attempt to take advantage of the mobility of mobile phones or synchronized performance over great distances. Instead, interaction is instigated through face-to-face communication, and aesthetics of teamwork and collaboration are brought to the foreground. Smule's *MadPad* has an interface with several similarities to *4Quarters*: a grid of samples are triggered by pushing buttons, based on older hardware push-button samplers such as MPCs.[15] Both *MadPad* and *4Quarters* encourage the use of sharing sets of pre-composed samples between users. Though multiple users could use iPads or iPhones as instruments to jam together in one room, the *MadPad* application's design highlights interaction between users within the *MadPad* community via sharing and downloading sets of video samples. Though *4Quarters* currently has no online framework to support the exchange of sets of sound files, the *MadPad* model for sharing content is highly desirable. By design both apps aim to obscure the notion that musical content is generated by a few people for the majority to consume.

5.3.3 Trajectory for Mobile Music-making

Mobile music-making—that is, a creative or performative form of making music on mobile devices—is not a mainstream trend, but its presence cannot be entirely dismissed as a fad. Although the most popular music apps currently available for phones are music discovery or music streaming apps that reflect a passive consumption model, there are indications that mobile music-making is also gaining ground. For a comparison, the leading internet radio

[14] Knowles and Paek, "3001: Collaborative Musical Gameplay;" Smule, "MadPad."
[15] inMusic Brands, "MPC Series."

service, Pandora, currently has 62.5 million unique active users.[16] By contrast, Smule's catalogue of mobile music apps, all of which aim to engage the user to create music, has accumulated roughly 65 million total downloads by September of 2012, with an active user base of 15 million.[17] Although Smule's user base is roughly a quarter of Pandora's, the numbers do suggest that there is a significant segment of the population that is interested in using mobile technology to generate musical content. Although Pandora and the Smule applications represent two ways of interacting with music, there is an inherent tension imbedded within the approaches—consumption vs. creation—that dates back to the advent of recording technology. Ge Wang notes:

> If there's that desire in all of us to be musical, then if technology changed behavior one way, we may be at a crossroads of using technology to pass into that part of ourselves once again.[18]

The stance here is that recording music technology changed mass cultural behavior, shifting music away from a creative activity to a passive activity for the vast majority of people. Mobile phones now allow an avenue to change behavior once again. Wang continues,

> We're very happy to see things moving away from the perception that you have a few individuals producing music and the rest of us consuming it. The lines are being blurred, and we want to help that happen even more.[19]

Because there is no forthcoming technology that stands to replace the mobile phone as a de facto ready-at-hand device for billions of people worldwide, it is reasonable to assume that

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[16] Pandora disclosed that they have 175 million users as of October 2012, with 75 percent of Pandora's listening hours occurring via mobile devices. The figure used here is in reference to unique monthly users, not simply dormant accounts. Charlie White, "Music Services Compared: Pandora, Spotify, Slacker, and iHeartRadio," *Mashable*, February 13, 2013, accessed February 26, 2013, http://mashable.com/2013/02/13/music-services-compared-2/; Pandora Company Overview, last updated October 2012, accessed February 26, 2013, http://blog.pandora.com/press/pandora-company-overview.html.
[17] Smule News, last updated January 2013, accessed February 26, 2013, http://www.smule.com/news.
[18] Ge Wang, in Stuart Dredge, "Smule's new iPhone app would like to teach the world to Sing," *The Guardian Apps Blog*, August 8, 2012, accessed February 26, 2013, http://www.guardian.co.uk/technology/appsblog/2012/aug/08/smule-music-apps-sing.
[19] Ibid.

mobile music-making will advance. First, barring some unforeseen hazard, mobile phone subscriptions are not likely to decrease significantly any time soon. The devices are firmly entrenched in modern life. Second, as a result of a fairly stable market, mobile phone technology will likely become more advanced over time, with more features and better onboard sensors. Third, while improved technology may not necessarily be an indicator for attracting more people to use phones for making music, there are plenty of incentives for instrument builders to improve the music-making experience with mobile phones. The ease of dissemination, potential markets, and ever-improving hardware all form an attractive outlook for mobile instrument builders.

When asked about the trajectory of mobile music-making, Georg Essl responded:

> Mobile phones have a massive trajectory. Very soon literally everybody in the developed world will have a smartphone with substantial music performance possibility at his/her disposal. Even if we did nothing people will be playing music together.
>
> As for how that will go, I frankly do not know. I think there is potential for a lot, academically, as part of popular culture, in small groups, networked and so forth. What will stick and develop canonicity remains to be seen, but if one looks at the success of laptop orchestras, I don't see much of a hurdle for mobile phone orchestras. They are much cheaper to run, and allow much more varied (mobile!) modes of performance. There could well be a street art culture that uses mobile devices, etc.
>
> What I am fairly certain of is that live interactive electronic music performance is not a fad. That is here to stay. The only reason why we did not have this earlier was the limits of computational power and dissemination. But what shape it will take I don't know and I'm looking forward hopefully a lot of surprises![20]

As for the outlook for mobile music-making in general, it is far too early to come to definite conclusions. The purpose of this dissertation is to provide documentation for an emerging field, to promote the growing mobile music community, and also to chart the progress of a kind of music-making that is undergoing extremely rapid transformations, perhaps even faster than hardware and software options evolve. For the interested reader, it is my hope that this dissertation will provide an accurate snapshot of the relevant work, design issues, and social trends that encompass mobile phone music in the early stages of its development.

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[20] Georg Essl, email interview with author, January 29, 2013.

Appendix A – Gestural Control, Live Embodied Performance, HCI Design

Gestural Control

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Appendix B – Glossary of Technical Terms

12-key – A simple keyboard consisting of keys for numbers 0 through 9, along with keys for the asterisk (*) symbol and the pound (#) symbol.

abstraction – A reusable file made in Max/MSP that can be embedded into another patch. It is commonly incorporated for frequently repeated tasks.

Asterisk – A free and open source telephony platform that allows one to configure keypresses from phone calls to trigger events. It is maintained and developed by Digium, Inc.

client app – A software application on a mobile device that sends and receives data to a host/server application on a desktop/laptop computer.

dual-tone multi-frequency (DTMF) – A telecommunication signaling protocol over analog telephone lines in the voice-frequency band between telephone handsets and switching centers.

frequency equalization (EQ) – The process of balancing frequency bands within a digital or analog audio signal.

local area network (LAN) – A computer network that interconnects devices within a limited area such as a classroom, concert hall, or home.

Max/MSP – A graphic, modular programming language for interactive music, live performance, and multimedia. It is maintained and developed by software company Cycling '74.

Node.js – A software environment written in JavaScript and designed for server-side applications to facilitate even-driven, asynchronous input/output interactions with client web pages.

OpenSoundControl – A network-based data protocol similar to MIDI, used most typically to send messages between devices for triggering musical events.

patch – The name of a file created in Max/MSP.

poly~ object – An abstraction-based object in Max/MSP designed to generate multiple copies of a file. A particular advantage of using this object is that conserves CPU resources more efficiently than its alternatives.

Socket.io – A cross-browser JavaScript library for realtime web applications. It runs on both the client and server, but interfaces with Node.js on the server side. It primarily uses the WebSocket protocol.

web socket – A web technology the permits real-time interaction and data exchange between web browsers and web servers.

zero configuration networking (zeroconf) – A set of techniques that automatically creates a stable internet protocol (IP) network between two or more devices without needing manual configuration.

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