LONG DISTANCE RECORDING USING VIRTUAL DRUMS

A Document

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

Master of Music in Music Technology

EDUCATION TRACK

By

GREGORY MARAGOS
Phoenixville, Pennsylvania
2011

LONG DISTANCE RECORDING USING VIRTUAL DRUMS

A document submitted to the graduate school

in partial-fulfillment of the requirements

for the degree

Masters of Music in Music Technology

by

GREGORY MARAGOS

APPROVED BY
SUPERVISING COMMITTEE:

_____	_____
Supervisor: Lee Bilotta [	Date
_____	_____
Committee Member: William DeSanto	Date
_____	_____
Committee Member: Floyd Richmond	Date
_____	_____
Committee Member: Kent Smith	Date

Valley Forge Christian College

Phoenixville, PA

MAY 2011

ACKNOWLEDGEMENTS

I would like to thank Dave Anthony and Francis Camardella for their time, talent, and dedication to this research.

I would also like to thank Lee Bilotta, Dr. Floyd Richmond, and Dr. William Bauer for their advice and guidance.

ABSTRACT

The purpose of this mixed methods study was to research long distance recording via the Internet using the virtual drum software, BFD2. It was a two-part study that researched qualitatively the limits and possibilities of recording an album, collaborating long distance and then testing quantitatively if the results are the same as using non-virtual drums. A survey instrument was constructed from the long distance recording to test the null hypothesis that there would be no difference between live acoustic drums and BFD2 triggered drums. A random sample that included musicians (N=86) and non-musicians (N=42) was surveyed. The null hypothesis was accepted from the data results of the survey.

TABLE OF CONTENTS

ABSTRACT…….. v

LIST OF FIGURES…… viii

LIST OF TABLES…… ix

CHAPTER

I. INTRODUCTION……1

Purpose Statement and Hypothesis……..3

II. LITERATURE REVIEW ……4

Internet Music…….4

Virtual Instruments and Musical Perception..... 7

BFD2……..10

III. METHOD…….12

Participants……..12

IV. PROCEDURES……...14

Instruments……..14

Data…….14

Materials…….14

Sequence…… 14

Variables…… 17

Validity…….. 17

Data Analysis……..17

V. CONCLUSION……..19

BIBLIOGRAPHY……22

APPENDIXES……....25

LIST OF FIGURES

Figure

1. Effect Size……37

2. Survey Results…….38

3. Preference Survey……...39

LIST OF TABLES

Tables

1. t-Test Results……37

2. Survey Data……..40

CHAPTER I

INTRODUCTION

Today, the Internet enables the free flow of information on a volume never before experienced, and the pace of that development is ever increasing. According to Warchauer, the internet is the fastest growing technology in history. (Warschauer, 1997). The many impacts of the internet on society are sure to be topics of study for years to come.

In the field of music, the Internet has redefined the way people create, listen to, and consume music. Music recording artist John Mellencamp said, "the Internet is the most dangerous thing since the atomic bomb," his point being that the former manner of doing business within the music industry has been completely destroyed. ("John Mellencamp likens Internet to A-bomb - The Globe and Mail," n.d.). And there ***is*** a great transition in place. Stores that sell records and CDs are fading while Internet downloading services flourish (Smith, 2007). Cable music stations such as MTV have lost viewership while online databases of music such as *YouTube* have risen in popularity (Peer & Ksiazek, 2011). Traditional broadcast radio is still strong, but Internet based radio stations, and services such as *Pandora* flourish. While some see these changes as negative, some see great promise (Young & Collins, 2010).

One area of promise and interest for musicians is the opportunity for them to connect with one another via the Internet to compose or perform. This is evident in the number of web sites that are arising to help facilitate collaboration among musicians. At some of these sites, artists may upload an audio project, and invite collaborators from around the world to add additional tracks such as drums, bass, and other instrumentation depending on the needs of the project. Others permit songwriters, musicians, and producers to collaborate and record together using

their own existing digital audio recording platforms. While these public forums help facilitate online collaborations, the focus of this study will be the increasing speed of broadband Internet, believable virtual instruments, and affordable desktop audio workstations that enable independent collaborations.

The rise of the Internet also permits musicians to be more independent of major recording labels that were once necessary to provide wide spread distribution and professional musician networks. Composers can also now maintain more ownership of their works and wholly distribute their works digitally.

Even though there has been an increase in interest on the impact of music technology and the Internet, there has been little research done on long distance recording. Most research that has been conducted on music technology and the Internet has been about long distance in an educational setting. For example, school children in Vermont compose songs that are posted to the web, critiqued by teachers and others, and shared with the world (Estrella, 2005). Few studies have examined the functionality of long distance collaboration of recording and composing music using virtual instruments via the Internet.

The study of the long distance recording and virtual drums is important for several reasons. First, understanding the relationship of the Internet and music is important to the future of computer-based sound recording. Second, by using the Internet to compose and collaborate, musicians will not only be able to work with musicians hundreds of miles away but globally which could have a substantial impact on music. Finally, by exploring a MIDI based virtual drum instrument plug-in, musicians can send small files with ease to other musicians and create believable drum tracks.

This study will examine how realistic and functional long distance collaboration is when using MIDI-controlled, virtual-instrument plug-ins. This study will also consider whether the results produced are of the same quality as materials produced through conventional means.

Purpose Statement and Hypothesis

The intent of this two-phase, sequential mixed methods study was to research the process of long distance recording via the Internet using virtual drums. The first phase was a qualitative exploration of long distance recording via the Internet by recording journal observations, and by creating audio recordings of the process. Findings from this qualitative phase were then used to test the theory that there will be no observable difference between acoustic recorded drums and sampled BFD2 drums. BFD2, which stands for big friendly drums, is a virtual drum software plug-in that uses acoustic drum samples. These samples are triggered by either a MIDI keyboard or a through an electronic drum kit. The rationale for using both qualitative and quantitative data is that it is necessary to explore the process of long distance recording using MIDI sampled drums and to test quantitatively if BFD2 is as believable as acoustic drums.

The null hypothesis of this study is: There will be no observable difference between recorded examples of acoustic drums and drum examples created using BFD2.

CHAPTER II

Literature Review

There are three sections in this literature review. First, Internet music and long distance collaboration will be discussed. Second, there will be discussion of studies related to virtual instruments and musical perception relating to timbre. Finally, a background and definition of BFD2 will be explained.

Internet Music

Hugill (2005) classified Internet music into five major types: 1. music that uses the network to connect to physical spaces or instruments; 2. music that is created or performed in virtual environments, or uses virtual instruments; 3. music that translates into sound aspects of the network itself; 4. music that uses the Internet to enable collaborative composition or performance; and 5. music that is delivered via the Internet with varying degrees of user interactivity.

Music that uses the network to connect to physical spaces or instruments deals with on-line jamming, plug-in- and play, and international multi-musician bands. On-line jamming is when musicians connect to the Internet to make music either on a local network or as in the case of international Multi-musician bands, a global network. There have been many challenges and successes in this type of Internet music. Technical issues such as network latency, replicating visual cues, and achieving a good instrumental blend are a few of the drawbacks (Hugill, 2005). In 1994, the Res Rocket Surfer Project was created as the one of first virtual on-line bands ("Finally, the On-Demand, Online Garage Band Gets Real," n.d.). It had 1,000 members that communicated through a mailing list and FTP server. In 1997, a monthly subscription fee was initiated and the Res Rocket Surfer Client software debuted. Musicians used MIDI instruments

or traditional instruments that enabled MIDI protocol translation to play along in real time or record their part locally and upload it later to a virtual studio. In 1999, the Rocket network powered the first ever demonstration of online music jamming by using hundreds of people to join in on a BBC televised experimental recording of the Bob Marley song, 'Them Belly Full'. The single was recorded with a deadline of one hour in front of 55 million viewers (Garrigus, 1998). In 2003, Res Rocket was purchased by the software company Avid and disabled. Current sites which enable on-line jamming include the following: www.ejamming.com, www.indabamusic.com, http://mix2r.fm, www.ninjam.com, and www.yourspins.com.

Hugill's second category, music that is created or performed in virtual environments or uses virtual instruments, permits multiple users to manipulate multiple instruments. In this multi-user environment users have their own virtual instrument on which to perform(Hugill, 2005). This type of Internet music has been recently studied at Stanford University. Researchers from the Stanford Center for Computer Research in Music and Acoustics and the Stanford Humanities Lab performed two mixed reality shows at the Torino Milano International Music Festival in the fall of 2009. Performers used both acoustic and electronic instruments in Stanford, CA., and in Italy simultaneously on-line in a virtual environment before a live audience in Milan, Italy. The performers used Q3osc, a virtual musical environment built on Quake III, which is an open-source game engine. The Q3osc has also been used in concert performances by the Stanford Laptop Orchestra ("Virtual World Music Performance | Humanities at Stanford," n.d.). Another site, www.virtualmusicalinstruments.com allows users to learn and create music by playing a virtual guitar, drums, bongos, piano, and flute. The instruments can be manipulated by either using a computer keyboard or a mouse ("Musical Instruments online: Play virtual musical instruments at VirtualMusicalInstruments.com!" n.d.).

Hugill's third category, music that translates into sound aspects of the network itself uses the process of data mining. Data mining in music is the process of applying classifiers to music elements to create a composition. This Internet music also uses the Internet as data traffic that can be rendered into digital sound (Hugill, 2005). This type of Internet music can be classified as computer music and algorithmic composition ("algorithmic.net: algorithmic composition resources | Main," n.d.)

Hugill's fourth category, music that uses the Internet to enable collaborative composition or performance is varied and wide. There is a significant amount of collaborative tools available for musicians available on the Internet and many of which are free. Sites such as www.digitalmusician.net, www.esession.com, and www.kompoz.com are just a few that offer musicians ways to collaborate. Musicians can also collaborate using the Internet by using remote instrument tracking from different studios over the Internet. One such studio in L.A. that specializes in custom drum tracks is called Cave Studio owned by Ryan Hoyle. Cave studio also offers an FTP server that allows collaborations and file transfers. Hoyle has done remote drum tracks for artists such as Carrie Underwood, Deborah Gibson, and David Cook ("MAKING MUSIC FROM MILES AWAY.," 2009). An extremely important factor in on-line collaboration is the speed of the network. This is important not only for uploading and downloading files but also for the audiovisual and data streaming features (Cutler, 2007). Carot, Hohn, and Werner (2009) conducted a research on the Netjack tool to study sample accurate timeline synchronization. By applying their delayed feedback approach users could collaborate using digital sequencers on the Internet with minimal latency. The research concluded that it would require a large amount of Internet bandwidth to achieve this minimal latency. Musicians can also collaborate using instant message platforms such as iChat and

Skype with the addition of software like Ambrosia's WireTap Anywhere. WireTap Anywhere allows musicians to take the audio output from any Mac Application or DAW and play the output over Skype or iChat while chatting at the same time ("WireTap Anywhere | Ambrosia Software, Inc.," n.d.).

Hugill's final category, music that is delivered via the Internet with varying degrees of user interactivity is the most prevalent form of Internet music. This type of Internet music pertains to educational websites, Internet radio, and online music games (Hugill, 2005).

Virtual Instruments and Musical Perception

Virtual instruments are designed to emulate hardware synthesizers and also acoustic instruments. Some virtual instruments like BFD2 are sample based which use real recordings of instruments. Kontakt, Reason, and Logic's EXS24 are other examples of virtual instruments that use sounds that are stored in the software sample library. The samples are assigned to a key map and the user sends a MIDI signal that triggers the sample.

Virtual instruments are can also be created through synthesis modeling. Pakarinen, Puputti, and Välimäki (2008) created a virtual slide guitar using a time-varying digital waveguide string model that generates the contact sounds of a slide tube touching the strings. Another type of synthesis modeling that is used for percussion instruments is Physically Informed Sonic Modeling (PhISM). PhISM is a method used for systematically analyzing and parametrically synthesizing percussion instruments to improve upon methods of physical modeling (Cook, 1997).

There have also been studies examining the control of virtual instruments. Laurson, Norilo & Kuuskankare (2005) researched an overview of a synthesis language for virtual instrument

design and control using the PWGLSynth. PWGL, which stands for PatchWork Open GL, is a free cross-platform visual language based on Common Lisp, CLOS and Open GL. The PWGLSynth consists of two main parts: the C- component and the Lisp component. The C- component contains the library of synthesis boxes, real time scheduling, a sequencer, audio hardware support, MIDI support and other general-purpose tools. The Lisp component is used to access the synthesis box database provided by the C- component (Laurson et al, 2005). The PWGLSynth is used to bridge non-real-time computer assisted composition environments and real time synthesis systems. Where as the PWGLSynth is used for creating from a visual notation starting point, the SuperPolm MIDI Violin was developed to address the variety of human perceptual experiences that occur in a performance on a virtual instrument (Goto, 1999). The SuperPolm MIDI Violin was created to produce sound based on physical movement and gestures. By using the SuperPolm MIDI violin the performer can express complex musical ideas while triggering MIDI data (Goto, 1999).

The Dada Glove and Sonar are also virtual instruments created to enhance the relationship of body, gesture, and space in performing and composition by using gestures to trigger sounds (Chabot, 1993). The Sonar System is an instrument that is connected to the control pedal of a MIDI keyboard and can sense an object's position up to 10 feet away. The performer can move along the directional beam axis or stand in front of the beam to interrupt it as if it was a virtual keyboard. The Dada Glove is an instrument made of two plastic gloves that connects to the pedal inputs of a MIDI keyboard. The fingers of the gloves are fitted with photoelectric cells that plug into the control pedal input and micro switches that plug into the modulation pedal input. The fingers of the glove can be used to either trigger sound samples or choose sound samples (Chabot, 1993).

The quantitative portion of this study examined whether or not the sample could discern the difference between acoustic drums and BFD2 drums. Though there have not been studies that are identical to this study, there have been studies on music perception and timbre that are related.

Gregory (1994) examined the whether timbre effected the listener's perception of auditory streams by using synthesized orchestral instrumental timbres. The study concluded that auditory streaming by timbre depends on the particular dimensions of timbre and on other musical factors such as simultaneity, continuity, and harmonic relation (Gregory, 1994).

Goad and Keefe (1992) conducted a similar study on the effects of musical context and musical instrument characteristics on timbre discrimination in a concert hall. The study also concluded that musical instrument characteristics proved to be significant when it came to listeners discriminating tones and melodies. Timbre discrimination accuracy was more difficult for a percussive instrument such as a marimba compared to that of a flute. The sustained portion of a tone was found to be the dominant contributor of the total variance of subjective responses. The study also concluded that place dependence on timbre within any concert hall is more important for sustained instruments than percussive instruments (Goad & Keefe, 1992). Handel and Erikson (2004) did a study to see if listeners use timbre transformations to identify sound sources over various pitches and loudness. The study concluded that the mechanical restraints and physical properties of the instruments and voice play a critical role in listener's ability to build transformations.

In this study a sample of musicians and non-musicians were surveyed to see if they could perceive the difference between BFD2 drums and acoustic drums. It is interesting to note that while studies have shown musicians show a symmetrical response to timbre and pitch identity,

there have been no differences between musicians and non-musicians when it comes to judging timbre similarity (Lakatos, 2000).

BFD2

BFD2 is a sample playback engine that streams multi-channel audio recordings of drum, hi-hat, cymbal and percussion instruments being played in various ways, and recorded with multiple sets of microphones. BFD2 caches a short segment of the start of every sound in system memory. This allows the user to use sounds at various detailed levels. BFD2's user interface allows users to use its hyper-detailed sample library to simulate as if one were mixing a real drum kit. Each kit piece is sampled with various velocity layers that allow the user to recreate the sound of dynamic drumming and accenting. Each velocity layer consists of an audio file made up of multiple channels. These recordings are made up of multiple microphone recordings used to capture the kit pieces with various elements. The kick and snare pieces also have primary direct and bleed channels.

BFD2 also consists of four microphone buses, which are virtual groups of the microphone channels. The ambience bus consists of three channels: the overhead, room, and ambience. The fourth mic bus consists of a direct bus, which represents the direct mic channel of all the kit pieces mixed together.

The sounds for BFD2 were recorded in Studio 1 at AIR Studios at Lyndhurst Hall, Hampstead, London. The recording room in Studio 1 is medium to large sized and consists of wooden surfaces. When recording the drums for BFD2, the room was portioned into a slightly smaller space that is typical for drum recording.

All of the sounds for BFD2 were recorded through Neve's AIR Montserrat preamps into Pro Tools through Prism ADA-8 XR converters at a 24-bit resolution with a sample rate of 44.1 kHz. A variety of condenser, ribbon, and dynamic mics were used to record the drums at various positions.

The drums for BFD2 are a mixture of modern, vintage, and custom instruments. Two of the vintage drum kits are historic kits. The Ludwig 'Spiral' Vistalite Kit was played and once owned by the late John Bonham of Led Zeppelin and the Blue Oyster Ludwig Kit was played and owned by Ringo Starr of the Beatles. Some of the other kits include a modern DW Collector's Series, a vintage Gretsch Round-badge kit, a late 70s Rogers XP-8 kit, and an Orange County drum kit ("FXpansion - BFD2," n.d.).

CHAPTER III

Method

Participants

The participants in this study included the researcher in Philadelphia, Pennsylvania, a drummer/collaborator located in Atlanta, Georgia, and a random sampling of musicians and non-musicians who will took part in the online survey. The study also employed a music collaborator who is local to Philadelphia to assist in engineering, writing, and recording.

The researcher has been performing, writing, and recording music for about 20 years and has a good knowledge of the Internet, Apple OSX and of digital audio workstations. He has written music that has been played on local TV, ESPN radio, MTV, and featured on a nationally released compilation album. He has also performed music that has been used on television shows such as *ER*, *All My Children, Party of Five, Roswell,* and *Jake 2.0*. His first recording experience was with a Fostex 4 track and then ADAT recording many years later. ADAT, which stands for analog digital audiotape, is a tape format that allows users to record up to 8 tracks of digital audio at once onto magnetic tape. Additionally, the researcher has worked with a variety of recording software programs including: Cakewalk Home Studio, Cubase, MOTU Logic, Digital Performer, Logic, and Pro Tools LE and HD. He holds a Bachelor of Music in Jazz Composition degree from Towson University and is a TI:ME certified instructor.

The drummer/collaborator has been playing drums for 35 years and performing professionally for 24 years. He has had 7 years of private drum lessons and also has some basic keyboard skills. The drummer has a basic knowledge of Logic Express, GarageBand, and Mac OSX. His knowledge of recording comes from studio sessions in recording studios and recording

on his iMac using Logic Express and GarageBand. In addition to producing, mixing, recording, and engineering his own music, he has also worked with other bands in the same capacity to make demos. He has toured nationally several times and has recorded for record labels such as A&M Records, Le Disque Records, Star Records, Elektra, Columbia, Not Lame Records, and Virgin Records. The drummer has also worked with notable producers such as Nick Didia, Hugh Padgham, Jim Scott, and Don McCollister.

The music collaborator also has about 20 years of music experience. He has 14 years of recording experience that began with the digital audio workstation, Pro Tools LE. The collaborator has also worked with analog recording equipment such as SSL, Trident, Soundcraft, A&H, and TAC consoles and Studer tape machines. He has owned and operated a personal recording studio using various DAW's as tape machines and mixing on a 32 channel MIDI automated Sountracs Topaz British console. He has owned outboard gear from Trident, Grace Design, API, Universal Audio, TC Electronic, Soundtracs, Vintech, True Systems, Purple Audio, Shadow Hills, and others. The collaborator is up to date on modern DAW technology and is fluent using Pro Tools, Digital Performer, and Logic DAW platforms. He has co-written music that has been featured in an independent film and has co-engineered several Philadelphia band releases, such as Quick Step John and Jealousy Curve. He has also produced, engineered, and performed on albums from bands such as Overlook, The Blue Method, Blue Sinatra, Glasshouse, Vex X, Modus, Metroplex, and several others. The collaborator is currently a Technical Audio Engineer for NFL Films.

The random sample of musicians (N=86) and non-musicians (N=42) that took part in the survey ranged in age from nineteen to sixty three years old (See Table 2).

The research sites included the recording studio located at Valley Forge Christian College, Phoenixville, PA, the drummer's apartment in Atlanta, GA, and the researcher and collaborators' homes located in Philadelphia, PA.

CHAPTER IV

Procedures

Instruments

The survey tool that was used in this study is an online survey that included questions and audio examples of recordings that have the session drummer playing real drums and BFD2 drums (see Appendix 1).

Data

The data that was used for this study was a journal of field observations (see Appendix 2), an audio CD of a completed album using BFD2 (see Appendix 3), and an online survey (see Appendix 1). The researcher employed the instrument development model by collecting qualitative data first, which was then used to create the survey instrument (see Appendix 1).

Materials

The materials used for this study included: 2 iMacs, 1 MacPro, Logic Studio 9, Logic Studio Express, Pro Tools 8 HD rig, a Digi003,1 Macbook Pro, Skype, Echo Audiofire 8, Wiretap Anywhere, various acoustic and electric guitars and basses, Roland TD-20S electronic drum kit, Oxygen 61 Keyboard, Digidesign C24 and BFD2.

Sequence

The researcher and music collaborator created twelve demo files in Logic Studio that consisted of programmed BFD2 drum parts. These drums were to serve as a guide for the

drummer but not as final parts. The demos were rough versions of what the final arrangements will sound like. New Logic session files of the demos were created, which consisted of composite backing tracks and vocals. The Logic files also had a stereo software instrument track with BFD enabled. The drummer received mp3s of the demos as well as the Logic session folders via an FTP server.

The drummer opened the Logic files in Logic Studio Express and began programming drum parts in BFD2 using a MIDI keyboard. This allowed him to learn the BFD2 interface and create drum sounds as well as learn the form of the demos. As the parts were being created chats were held via Skype to troubleshoot and collaborate.

Once the drummer was ready to record the parts using BFD2, he used a Roland TD- 20S electronic drum kit connected to his iMac via a MIDI to USB cable. He recorded using the same Logic demo session files he downloaded at 44.1 kHz. This recording of the TD-20S took approximately two days. Once the drums were recorded the drummer uploaded the session folders to the researcher using an open source FTP. The researcher made a rough mix of the drums bouncing down the MIDI parts to audio and used Soundtrack Pro to resample the BFD2 parts to 88.2kHz. Some MIDI parts used from the demos, as well as guide vocals, were also re-sampled to 88.2 kHz. These re-sampled .wav files were then used to create new Pro Tools 8 HD sessions at the Valley Forge Christian College recording studio.

The researcher and music collaborator tracked vocals, bass, and guitar at VFCC to the bounced down BFD2 drum tracks as if they were real recorded drum tracks. Once the tracking was completed at VFCC, the .wav files were then inserted back into a new Logic Session file at 88.2 kHz that were created from the session files created by the drummer. This allowed the researcher to keep all the settings the drummer made in BFD2 during his recording process.

Files that were created at VFCC were inserted into the new Logic Session files and MIDI parts from the demos were also flown into the new session file. As the sessions were being mixed, the researcher worked with the drummer via Skype to listen to and tweak mixes so that the drums sounded as real as possible.

Once all the tracks were mixed, a survey was created using the Form Document in Google Docs. Three fourteen-second song examples of BFD2 that were recorded by the researcher and two fourteen-second examples of songs that had acoustic drums were chosen. The drummer performed on all of the examples. The survey form was then embedded into a webpage that was created for the survey. The five examples that were chosen were also embedded into the page. The examples were chosen very carefully selecting them with specific criteria in mind. Three of the examples were recorded using BFD2 during the research and the other two were live acoustic recorded drums. Example 1 is a song that was recorded with no vocals and with BFD2 triggered drums that were incorrectly triggered. The high hat was being triggered by the toms and did not sound realistic. Example 2 was a recording of acoustic drums from the song 'Sing' recorded by the band Quick Step John. The drums were heavily processed and the piano was created using a plug-in instrument. The third example was another BFD2 example recorded during the study. It also featured a plug-in upright piano sound but also had acoustic guitars and bass. Example 3 also featured ghost noting on the snare, which might throw off listeners. Example 4 was acoustic drums from the song 'I Thought You Knew' recorded by the band Ike. This example had heavily compressed drums and a very dry tom tom sound. Example 5 was BFD2 drums recorded during the study, which had acoustic guitars, cellos and plug-in strings.

The examples were combined with questions that were inputted into the on-line survey. The survey was administered to a random sample of musicians and non-musicians ranging from college students to professionals. The results were analyzed to see if the null hypothesis was true.

Variables

The independent variables in this study were the acoustic drum examples, the software BFD2 and the survey participants. The dependent variable was the results from the on-line survey.

Validity

The type of internal validity threat in this study was history. It would be hard to know how much exposure the surveyors have had to electronic drums as compared to acoustic drums. Other threats are the lack of control over the participant's environment when taking the survey on the Internet and the susceptibility to fake responses.

The threats to external validity were generalizations that the sample data is conclusive of age, socioeconomic status, gender, and geographic regions. To be conclusive additional experiments would need to be conducted in various settings with various populations.

Data Analysis

The on-line questionnaire was analyzed using descriptive statistics. The results of the survey were compared using a t-test for independent means (see Table 1). The first example was not averaged because it was intentionally made to sound triggered with BFD2. The scores from examples 2 and 4, which were acoustic drums, and the scores from examples 3 and 5, which

were BFD2 drums, were averaged. The mean score for the acoustic drums was 3.35 and the mean score for the BFD2 drums was 3.82. The t-test results were: $t(126)=1.96, p<.05$. This obtained critical value was not larger than the 1.96 critical value needed to reject the null hypothesis. The null hypothesis, there will be no observable difference between recorded examples of acoustic drums and drum examples created using BFD2, was therefore accepted. The effect size was also calculated to measure how different the scores were from one another (see Figure 1). The effect size was calculated to be -.041, which showed that both group scores were very similar.

A question on the survey also asked the population their preference of the drum examples. 34% preferred example 2, which was live acoustic drums (see Table 4), but it was only preferred by 4% to the BFD2 example 5 which scored a 30% preference.

CHAPTER V

CONCLUSION

This study proved that it is possible to collaborate long distance via the Internet using virtual drums to get results that are as believable as acoustic drums. This could have a great impact on the future of recording studios and also session musicians who can now work from home. The use of BFD2 also makes it more affordable to get professional sounding results without having to purchase the acoustic drums, the mics, and outboard gear required to record the drums used in BFD2. The drummer in the study who had no prior experience with BFD2 at the start of the research now is going to start to use BFD2 to become a session drummer from home using Logic Express on his computer.

There are improvements that could be made to BFD2. There were many instances where the variable hi-hat settings of BFD2 were a nuisance. Once the variable high-hat setting was selected it was difficult to edit the hi-hat in the MIDI piano roll. BFD2 was also very taxing on the RAM and CPU with regard to recording and playback. The BFD2 track had to be converted from MIDI to audio because it would limit the amount of tracks and plug-ins that could be used on other tracks. It is possible to mix the drums inside of BFD2 using their mixer but it is very CPU intensive. BFD2 also needs to be made available as 64-bit instead of 32-bit since many of their competitors, such as Native Instruments, have already begun to do so. This would allow users to access more RAM and to load and play drum kits faster. Overall, despite some of its flaws, BFD2 did perform and produce great sounding sampled drums.

Collaborating via the Internet was done with ease using e-mail and Skype. File size was only an issue when it came to swapping entire Logic project files. If the file size was too large to

send using a Google mail account the researcher used either Sendspace or his Mobile Me public folder. Proper labeling of files with the date and version was essential when dealing with the multiple collaborators. Using multiple external hard drives, e-mail accounts, and back up devices also required much diligence to advert data loss.

This study opens many ideas for future research using a variety of other virtual instruments that could also be surveyed. The piano, in particular, is an instrument that is greatly sampled but rarely has believable results to the ears of musicians and non-musicians. There are also many more other virtual drum software programs that could be researched by the same means as this study. Another interesting future study could be how acoustic instruments, when mixed with virtual instruments, effect the listener's perception. The acoustic instruments in the listening examples could have possibly swayed the listener's ears to think the drums were more realistic. Additionally, a study of the drums without other instrumentation might have had different results than this study.

Another interesting dilemma that occurs when using digital recording software and virtual instruments is the lack of final decisions and commitment. The user is presented with so many choices, all of which are not final causing the user to make endless tweaks. Even at the end of the mixing, the drummer and researcher were changing drum kits in BFD2. Performance parts in BFD2 were also changed with relative ease. This kind of freedom, which is not allowed when recording acoustic drums, can have its benefits and its drawbacks.

One can only imagine what is in store for the future of recording and the music business when it comes to technology. The speed of the Internet may increase to the point where virtual instruments are no longer necessary. Musicians may be able to send large files quickly and play

acoustic instruments in real-time without any latency issues. One thing that seems certain is the Internet will play a large part in whatever the future holds for music.

BIBLIOGRAPHY

algorithmic.net: algorithmic composition resources | Main. (n.d.). . Retrieved September 25, 2010, from http://www.flexatone.net/algoNet/

Carot, A., Hohn T., & Werner C. (2009). Netjack-remote music collaboration with electronic sequencers on the Internet. Retrieved February 20, 2011, from lac.linuxaudio.org/2009/cdm/Saturday/22_Hohn/22.pdf

Chabot, X. (1993) To Listen and to See: Making and Using Electronic Instruments. *Leonardo Music Journal*, Vol. 3, 11-16

Cook, P. R. (1997). Physically Informed Sonic Modeling (PhISM): Synthesis of percussive sounds.*Computer Music Journal*, 21(3)

Cutler, M. (2007). THE WORLD IS YOUR WORKSTATION. *Electronic Musician*, *23*(10), 38-51.

Estrella, S. (2005). The Vermont MIDI Project. *Music Education Technology*, 3(1), 10- 42.

Finally, the On-Demand, Online Garage Band Gets Real. (n.d.). . Retrieved September 11, 2010, from http://www.wired.com/entertainment/music/commentary/listeningpost/2007/04/listeningpost_0430

FXpansion - BFD2. (n.d.). . Retrieved September 25, 2010, from http://www.fxpansion.com/index.php?page=53&tab=149

Garrigus, S. R. (1998). Jammin' over the Net. *Electronic Musician*, *14*(10), 134.

Goad, P.J., & Keefe, D.H. (1992). Timbre Discrimination of Musical Instruments in a Concert Hall, *Music Perception: An Interdisciplinary Journal, Vol. 10, No. 1,* 43-62

Goto, S. (1999). The Aesthetics and Technological Aspects of Virtual Musical Instruments: The Case of the SuperPolm MIDI Violin. *Leonardo Music Journal*, 9(1), 115-120. doi:10.1162/096112199750316901

Gregory, A.H. (1994). Timbre and Auditory Streaming. *Music Perception: An Interdisciplinary Journal*, Vol. 12, No. 2, 161-174

Handel, S., & Erikson, M. (2004). Sound Source Identification: The Possible Role of Timbre Transformations, *Music Perception: An Interdisciplinary Journal, Vol. 21, No. 4*, 587- 610

Hugill, A. (2005a). Internet music: An introduction. *Contemporary Music Review*, *24*(6), 429-437. doi:10.1080/07494460500296094

John Mellencamp likens Internet to A-bomb - The Globe and Mail. (n.d.). . Retrieved August 25, 2010, from http://www.theglobeandmail.com/news/technology/personal-tech/john-mellencamp-likens-internet-to-a-bomb/article1677018/

Lakatos, S. (2000). A common perceptual space for harmonic and percussive timbres. *Perception and Psychophysics*, 62, 1426–143

Laurson, M., Norilo, V., & Kuuskankare, M. (2005). PWGLSynth: A Visual Synthesis Language for Virtual Instrument Design and Control. *Computer Music Journal*, 29(3), 29-41. doi:10.1162/0148926054798223

Making Music From Miles Away. (2009). *Canadian Musician*, *31*(4), 18.

Musical Instruments online: Play virtual musical instruments at VirtualMusicalInstruments.com! (n.d.). . Retrieved September 18, 2010, from http://www.virtualmusicalinstruments.com/

Pakarinen, J., Puputti, T., & Välimaäki, V. (2008). Virtual Slide Guitar. *Computer Music Journal*, 32(3), 42-54

Peer, L., & Ksiazek, T. B. (2011). YOUTUBE AND THE CHALLENGE TO JOURNALISM. *Journalism Studies*, 12(1), 45-63. doi:10.1080/1461670X.2010.511951

Smith, E. (2007, March 21). Sales of Music, Long in Decline, Plunge Sharply. *Wall Street Journal - Eastern Edition*. pp. A1-A14.

Virtual World Music Performance, Humanities at Stanford. (n.d.). . Retrieved September 18, 2010, from http://humanexperience.stanford.edu/virtualperformance

Warschauer, M. (1997). Computer-Mediated Collaborative Learning: Theory and Practice. *The Modern Language Journal*, *81*(4), 470-481.

WireTap Anywhere , Ambrosia Software, Inc. (n.d.). . Retrieved September 18, 2010, from http://www.ambrosiasw.com/utilities/wta/

Young, S., & Collins, S. (2010). A View from the Trenches of Music 2.0. *Popular Music and Society*, *33*(3), 339-355. doi:10.1080/03007760903495634

Appendixes 1

On-Line Survey

Music Questionnaire

Listen to the six musical examples and decide if the drums sound realistic based on a scale of one (non-realistic) to five (very realistic). Once you have completed the examples please answer the questions.

* Required

Musical Example 1 *

	1	2	3	4	5	
Non Realistic	○	○	○	○	○	Very Realistic

Musical Example 2 *

	1	2	3	4	5	
Non Realistic	○	○	○	○	○	Very Realistic

Musical Example 3 *

	1	2	3	4	5	
Non Realistic	○	○	○	○	○	Very Realistic

Musical Example 4 *

	1	2	3	4	5	
Non Realistic	○	○	○	○	○	Very Realistic

Musical Example 5 *

	1	2	3	4	5	
Non Realistic	○	○	○	○	○	Very Realistic

Musical Example 6 *

	1	2	3	4	5	
Non Realistic	○	○	○	○	○	Very Realistic

Age *

Are you a professional musician or student? *

Which example did you prefer? *

- Example 1
- Example 2
- Example 3
- Example 4
- Example 5
- Example 6

Submit

Appendixes 2

Thesis Journal

8/13- Dave receives BFD FedEx package

8/16-8/18- created Logic project sessions this had backing tracks from the logic demos minus the drums. Each Logic project had two tracks: a backing track and BFD stereo software instrument track. I ran a compressor on the master channel and made sure no files clipped. I also set the tempos for each track and setup the click channel to be visible on the mixer in Logic. I uploaded the folders to an FTP using the cyberduck application.

8/18 Dave installs BFD and calls to ask about authorization. I instruct Dave to install BFD on an external drive and not his internal drive.

8/19 I upload some BFD tutorials for Dave to watch and I instruct Dave on how to use cyberduck to download the logic project folders. Dave begins to explore how to use BFD by programming drums by keyboard on the song 'Everyday' using Logic express. We decide this will be the best approach to have Dave program all the songs with his keyboard before renting the electronic drums. This will allow Dave to learn the songs and get his drum sounds before renting. Dave and I use skype for audio and use the share screen option to show Dave how to set logic so that when he records MIDI it will converge a new recording with an old recording. This allows Dave to record the hi-hat and kick and snare drums separately on the same track. We also reconfigure the BFD track to Multi-output for each project. My reason for this is I plan to build my tracks in the studio from his Logic projects and this will allow me to use BFD the way he set it up. We also use skype to have Dave send me an mp3 of the song 'Everyday' that he programmed. He has difficulty with the bounce because some the sounds are not sustaining

8/24- Dave calls me to tell me that he is having difficulty recording because Logic is telling him he is running out of memory. There are two reasons for this: he is running multiple tracks of BFD which is extremely taxing on his RAM and he is pressing play on the track not allowing the kit pieces enough time to load up. I also advise Dave to run his Logic project sessions from his external hard drive. He is still having the problem of his BFD tracks cutting short cymbals when he bounces to an mp3. He sends me the logic session folders thru sendspace to see if I have the same issue on my computer. When I open the projects, I find that BFD saves all his settings within the project. I also have the same issue with the samples being shortened but I find playing the files all the way thru and also restarting my computer before I use Logic helps.

8/26- I meet with Lee at VFCC and see what new additions have been made to the studio. The studio has a Digidesign C24 controller but I learn from some Google searching it is not compatible with Logic.

8/27-9/5- I move all the project folders to a designated a HDD for recording. I create a composite backing track from demos of the tracks we will not be re-recording for the project. These files are mostly midi files that use plug-ins. I also create a composite guide vocal track. These tracks are saved as 24 bit wave files at 44.1. I save all the files to their perspective track folders entitled 'song name PTHD audio' I also create pro tools 8 LE sessions for each track and set the tempo and click as well as import the wav. files that I made.

9/5 Fran and I decide we want to track at 88.2 using the PT HD rig. This means that all the previous files I made for PT now need to be resampled using Soundtrack pro. I also bounce down any BFD files I have to audio so that they can be resampled to 88.2. This will allow us to begin tracking acoustic guitars while Dave is still working on the BFD programming. I had

difficulty with BFD bouncing tracks without 'sound glitches' so I bounced the MIDI to audio in 'real time' and found that helped.

9/7- I resampled backing tracks to 88.2kHz using Soundtrack pro. Found a shortcut that you can resample tracks by just using 'save as' to 88200. I also found a bug in the soundtrack pro that if the track header is not all the way rewound when you save it would crash soundtrack pro.

9/8- Received a call from Dave saying that his BFD2 was no longer authorized. I had to contact support and request another authorization. I went into the studio at VFCC to create PTHD sessions in 88.2kHz. I had difficulty lining up the tracks I created in Logic when they were imported into PT. I spent about 2 hours lining up the tracks. Recorded some test tones using the 414 condenser mic.

9/9- I heard back from BFD2 and they granted me another authorization. This fixed Dave's problem. We had a phone conversation also about his low memory errors he was receiving. I suggested that he try not programming the drums with effects enabled in BFD2. These effects could be added after the performance to help free up some RAM memory when recording.

Went into the VFCC studio again to record acoustic guitars to the tracks I had made with Dave's programmed BFD drums. I recorded one acoustic guitar track with my Martin and the u87 thru the Avalon at the 12th fret position on 'This is Not an Exit'.

When Fran arrived, we experimented with using the m130 mic thru the API lunchbox and the u87 thru the Avalon. The m130 signal was too weak so we ended up using the u87 thru the Avalon at the 12th fret position and the m160 thru the API/purple/Pacifica at sound hole position. I used both the Martin and the Taylor to record 3 takes. I recorded two takes with the martin and one take with the Taylor. We finished all the acoustic parts for ' Don't Write Me off'. We

started to record 'Moving Moving Moving' but had problems with he click not aligning with the tracks.

9/10- Worked at school using the digi003 to try to figure out what the problem was with 'Moving Moving Moving'. I opened the original logic session and noticed it was in 3/8 at 85 bpm and the logic session Dave used was in 6/8 at 85 bpm. I tried setting the click to that in PT but it kept getting off and giving me the right subdivision. I finally fixed it by setting the resolution to 16th notes. I also remembered Fran telling me that PT starts at 0 while Logic starts at beat 1. By dropping a beat in the PT session, everything locked up. This was also the problem I encountered the other night when I was creating the PTHD sessions.

9/15-9/16 Recorded acoustics again this time using sm81s. One sm81 ran thru the API the other thru the Pacifica and the purple compressor. The mics were set in the same approximation one between the sound hole and bridge, the other at the 12 fret. We primarily used the Martin for all the tracks.

9/18- I discovered today that Logic would resample when you bounce an audio track. When saving as a .wav file you are given sample options. This eliminates the need for using Soundtrack Pro.

9/20- Notes were compiled from Fran and I to be e-mailed to Dave.

9/21- Dave emailed me again today to let me know that BFD had authorization issues. I contacted Fxpansion with the open ticket number and they granted me another authorization. It seems that if Dave does not use BFD for several days there are authorization issues.

9/22- Recorded acoustic guitars for 'Umbra Penumbra' today using the Martin and the two sm81 mics. We used the same signal path of the API and Pacifica/purple comp as well as the same position with the mics.

9/23- Recorded 12 string guitar parts using the m130 thru the Avalon preamp. These parts were recorded at the 12th fret position.

9/26- I did a conference chat with Fran and Dave using skype. All of the demos have now had Dave's programmed BFD drums. The week before Fran and I made notes on things that we would like Dave to do off the demos. This is the final discussion we have on the parts before Dave tracks the drums using an electronic kit. It's important that we are on the same page because Dave is renting the kit for two days and he has to cut all 12 tracks in those two days. We try to use the Wiretap Anywhere Demo to listen to the demos that Dave made together. I get the outputs patched right, but on the Demo there is a female voice every 20 seconds saying that it is the demo. We go ahead and just have Fran or Dave play the songs on their monitor and the sound is picked up by their internal mics on their computers. They use headphones to prevent feedback from their mics on their macs. We go down a list of every song. For each song we played our demo, and then listened to Dave's drums that he programmed. We decide that Dave will not record drums to 'I am where I belong' because the programmed drums sound suitable for the style of song. This means that Dave will only have to record 11 tracks. Dave also explains his compositional process of how he came up with his drum parts. He explains the necessity of having a solid groove and less sectional grooves in our arrangements.

9/29- Dave rents a Roland TD-20s kit for two days. He records two tracks this day and spends most of the time trying to get the TD-20 to react the way an acoustic kit would react. The biggest problem he is having is with the hi-hat. We have a skype chat in the afternoon and realize that Dave has not updated BFD2 to 2.1. By updating to the most recent version this fixes a lot of issues he was having with authorization and memory usage. This update also has a variable hi-hat setting, which helps his hi-hat issues.

9/30 -Dave completes the tracking of the drums using the TD-20. Fran and I go to the VFCC studio to record acoustic guitars for 'Don't Bury Me Alive'. We use the same signal chain and mic set up we have been using. We also have a skype chat with Dave as he completes the drums. Dave is having troubles with hearing open hi-hat sounds when he did not trigger them. He creates a new MIDI track and copies the old track to the new track. This gets rid of the unwanted hi-hat sound. We also conclude that it is probably a MIDI panic issue. Another issue he is having is locating hi-hat sounds. Because he is using the variable hi-hat sounds, it does not map to a certain keyboard note on the Logic piano roll. This is an issue if you want to edit a hi-hat in the piano roll. I figure if we need to copy a hi-hat we can copy and paste once we have bounced the hi-hat track to audio.

10/3- Dave sends me his key map files that he created to me in an e-mail. I will now be able to import his key map which will allow me to edit his drums.

10/6 and 10/7- continue to record acoustics at VFCC using the KSM137 mic and with the martin and API/Pacifica/Purple setup

10/9- recorded bass DI at AAA using Digi003 thru API/Purple. I recorded the bass using 'line in' bypassing DIGI003 's preamp. I used Rickenbacker, Hofner, Jazz, Jazz fretless, and Precision basses.

10/13- recorded Acoustics at VFCC

10/14- continued to record bass DI at AAA

10/16- recorded guitars at VFCC. I used Dr. Z and Fender pro junior amps. We used u87 and sm57 to mic the amps. For guitars we used my 1965 reissue Tele for all the electric guitar parts.

10/17- continued to record electric guitars decided due to the amount of tracks it will be better to use one mic (the SM57) to record electric guitars.

10/20- I recorded bass at home using my Presonus inspire 1439 and Logic Pro

10/21- I finished Bass DI tracks and all edits/comps at AAA

10/23- We reamped the bass parts at AAA using a custom-made reamp box made from a crybaby wha pedal that serves as a true bypass. Used the ampegv4b and 410 HE cabinet for the jazz and precision bass. I also used the ashdown 15 combo for the fretless, Rickenbacker, and hofner basses. We created a cue mix to monitor the bass while it was being recorded. We moved the amps into a private lesson studio that had sound treatment and was sound proof. Used a Beta 52A to mic both amps and ran it thru the API preamp. Sometimes we applied some compression to the ashdown bass tracks using the purple compression. After each track was recorded, I then checked for phase issues and then adjusted the amp track to the DI track to deal with latency issues.

10/27- We recorded electric guitars at Fran's. I created a mixdown of two tracks in PT in 88.2 to import into new Logic sessions for electric guitar. Fran placed his Dr.Z cabinet in his basement and miked it with a SM57 thru a piece of foam. Fran took the amp out of the combo unit and placed it on his desk to allow us to make adjustments with running down to his basement. We recorded all these tracks thru the API and Pacifica and thru an echo audiofire interface. We also used guitar rig 3, and Logic's pedalboard for some of the effects. We used Fran's Butterscotch 2007 Fender Tele for both tracks.

10/28- We continued to record electric guitars at Fran's. We used a 2008 Fender Strat for some of the guitar parts for 'Everyday' and also Fran's 2007 FenderTele.

11/1-12/29- We cut lead vocals at VFCC using the Neumann u87 and the Avalon preamp. We also used the Pacifica and API for a few tracks. Some lead vocals were cut at Fran's using a

SM7 and the API preamp. All backing vocals were cut using the SM7 thru the API preamp except for 'Moving Moving Moving' which we used a AKG 414.

1/3- We began mixing after all the files are taken out of the PT 8 sessions and imported into Logic 9. This went pretty smooth. I created continuous audio files of each track in PT9 making sure all the files started at beat 1. I then bounced all the files to another folder entitled 'logic Mix Files' for each song. I then created a new Logic Mix session for each song at 88.2 from the original TD-20 Sessions. I took the logic mix folders I created and dragged them into the logic mix sessions. Logic imported the folders with all the tracks and created new tracks. All of the tracks were in their right place since I bounced them at beat 1. I then opened other logic sessions that were created such as guitar sessions or demos sessions and imported the tracks we wanted to use. This was done by selecting the media tab in logic and then finding the folder of the session of the song I was looking for. I then selected the tracks I wanted from the session and added them to the mix session. The tracks imported at the proper beats without having to bounce to one like PT8. Logic automatically up-sampled tracks to 88.2 if the sessions were at a different sample rate. Overall it was much smoother going from PT8 to Logic 9.

Mixing began once the BFD2 tracks were created into audio files. I opened BFD2, cleared the mixer, and reassigned the tracks to new aux channels. Logic only allows 8 Mono and 8 Stereo multi outputs. This caused us to combine some drum tracks to one drum track. . We used all 8 Mono outputs and four Stereo outputs.

Our standard bounce down of logic tracks were:

Mono 1: Kick Out

Mono 2: Kick In

Mono 3: Snare Bottom

Mono 4: Snare top (two snare tops routed into an aux channel in BFD2)

Mono 5: High Tom

Mono 6: Floor Tom

Mono 7: High Hat

Mono 8: Ride cymbal

Stereo 1: Cymbals (two crash cymbals routed into an aux channel in BFD2)

Stereo 2: OverHeads

Stereo 3: Room Mics

Stereo 4: Ambience Mics

All of the BFD tracks were bounced dry with no effects into tracks in Logic paying special attention to gain structure. Some last minute adjustments were made within BFD2 to control bleed and velocity.This was done by routing the outputs of each multi-output to a bus that was the input of the new audio tracks. The audio tracks were recorded in real time from BFD2 to Logic 9 at 88.2. Once the BFD2 tracks were recorded into 12 audio tracks, BFD2 was deleted from the session. This help free up a considerable amount of CPU and allow us to use plug-ins outside of BFD2 to drum tracks.

Appendixes 3

CD Track Listing

1. Everyday 3:54 (Camardella/Maragos)
2. Time Machine 5:46 (Camardella/Maragos)
3. This is Not an Exit 3:20 (Camardella/Maragos)
4. High Wire 4:32 (Camardella/Maragos)
5. Fair Weather 4:21 (Camardella/Maragos)
6. Back to the Start 4:52 (Camardella/Maragos)
7. Worst Way 4:38 (Camardella/Maragos)
8. Don't Write Me Off 3:38 (Camardella/Maragos)
9. Moving Moving Moving 4:35 (Camardella/Maragos)
10. Matter of Time 4:00 (Camardella /Maragos)
11. I am Where I Belong 3:58 (Camardella/Maragos)
12. Umbra Penumbra 5:08 (Camardella/Maragos)

Figure 1

Effect size

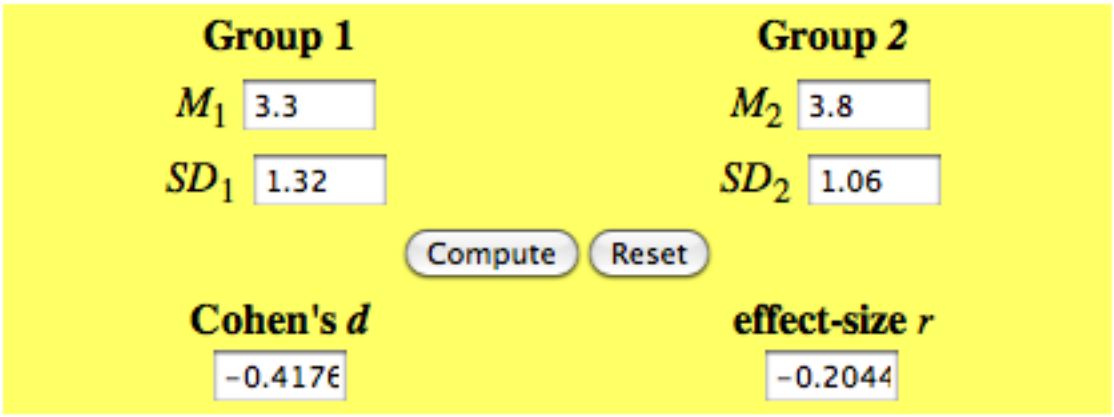


Table 1

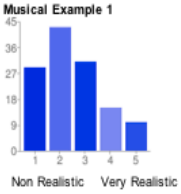
t-Test Results

t-Test: Two-Sample Assuming Equal Variances

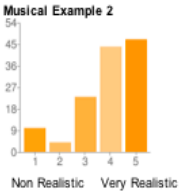
	Variable 1	*Variable 2*
Mean	3.355469	3.824219
Variance	1.767264	1.141529
Observatio	256	256
Pooled Vari	1.454396	
Hypothesiz	0	
df	126	
t Stat	-4.39749	
P(T<=t) one	6.67E-06	
t Critical on	1.647847	
P(T<=t) two	1.33E-05	
t Critical tw	1.964626	

Figure 2

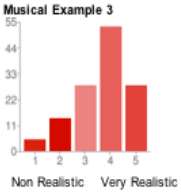
Survey Results



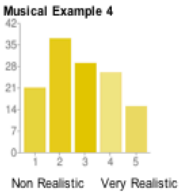
1 -	Non Realistic	29	23%
2		43	34%
3		31	24%
4		15	12%
5 -	Very Realistic	10	8%



1 -	Non Realistic	10	8%
2		4	3%
3		23	18%
4		44	34%
5 -	Very Realistic	47	37%



1 -	Non Realistic	5	4%
2		14	11%
3		28	22%
4		53	41%
5 -	Very Realistic	28	22%



1 -	Non Realistic	21	16%
2		37	29%
3		29	23%
4		26	20%
5 -	Very Realistic	15	12%

1 -	Non Realistic	5	4%
2		5	4%
3		27	21%
4		41	32%
5 -	Very Realistic	50	39%

Figure 3

Preference Survey

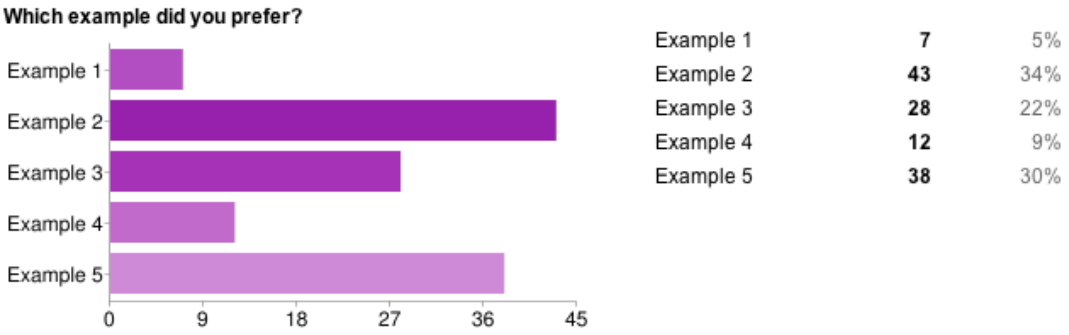


Table 2

Survey Data

Timestamp	Age	Musical Example 1	Musical Example 2	Musical Example 3	Musical Example 4	Musical Example 5	Are you a professional musician, non-musician, or student?	Which example did you prefer?
1/23/2011 11:13:59	49	3	4	5	2	5	I am a Professional Musician.	Example 5
1/23/2011 11:33:01	26	1	3	4	2	5	professional musician non musician, though I have studied drums	Example 5
1/23/2011 11:46:58	27	3	4	4	2	4	a bit profession	Example 2
1/23/2011 12:05:39	26	3	4	5	2	5	musician/producer	Example 2
1/23/2011 12:12:51	52	2	4	5	3	4	non-musician have a music background, can play instruments, just not	Example 3
1/23/2011 12:17:06	38	2	3	3	3	3	professionally	Example 4
1/23/2011 12:22:41	28	1	5	4	3	5	non-musician.	Example 2
1/23/2011 12:34:36	54	3	4	3	2	4	musician hobbiest	Example 5
1/23/2011 12:51:14	35	1	5	3	3	5	I dont consider mysefl a musician, though I can read music and play piano	Example 2
1/23/2011 12:51:28	35	1	5	3	3	5	I dont consider mysefl a musician, though I can read music and play piano	Example 2
1/23/2011 12:55:34	37	2	4	4	3	4	non-musician	Example 3
1/23/2011 13:21:29	52	1	5	2	4	4	non-musician	Example 2
1/23/2011 13:25:15	34	5	5	5	5	5	Musician non-professional musician, of the singing variety. Also a student, but not of	Example 1
1/23/2011 14:00:10	30	2	5	3	4	4	music.	Example 2
1/23/2011 14:36:33	25	3	5	5	5	5	Professional.	Example 5
1/23/2011 14:38:28	52	2	5	4	2	4	non-musician	Example 3
1/23/2011 16:07:59	27	1	5	5	2	4	non-musician	Example 2
1/23/2011 16:14:42	34	1	4	3	2	1	non-musician	Example 2
1/23/2011 18:29:50	28	3	5	4	3	5	Non-professional musician	Example 5
1/23/2011 19:41:40	38	2	4	4	4	3	Musician...non professional.	Example 2
1/23/2011 19:47:25	40	2	4	4	2	2	Non-musician	Example 3
1/23/2011 21:18:53	26	2	4	3	5	4	I am a full time student who plays music for not nearly enough money.	Example 4
1/23/2011 21:48:55	25	1	3	5	1	5	Professional Musician with a Bachelor of Music	Example 3
1/24/2011 1:26:25	34	4	5	3	1	5	non-musician	Example 2
1/24/2011 6:28:23	34	4	5	4	3	4	music educator	Example 2
1/24/2011 7:44:17	29	3	4	2	2	3	Music Teacher	Example 2
1/24/2011 7:44:28	39	4	5	4	3	5	non-musician	Example 2
1/24/2011 8:38:58	38	5	4	5	1	5	Professional.	Example 1
1/24/2011 8:39:48	42	3	5	4	4	4	professional	Example 2

Timestamp	Age	Musical Example 1	Musical Example 2	Musical Example 3	Musical Example 4	Musical Example 5	Are you a professional musician, non-musician, or student?	Which example did you prefer?
1/24/2011 17:11:20	30	2	3	5	2	5	professional musician	Example 2
1/24/2011 17:43:20	39	1	2	2	4	3	Professional musician	Example 2
1/24/2011 17:46:49	20	3	1	4	1	4	Semi-professional musician	Example 3
1/24/2011 18:14:25	24	2	3	4	2	4	musician	Example 3
1/24/2011 18:18:38	27	4	4	4	4	4	Non-Musician...Probably the reason they all sounded the same to me!	Example 3
1/24/2011 18:41:23	31	5	3	4	1	5	professional musician	Example 5
1/24/2011 18:45:01	27	2	3	4	1	3	yes	Example 3
1/24/2011 19:11:39	40	1	3	1	1	3	professional musician	Example 5
1/24/2011 19:18:48	29	4	4	4	5	5	Professional Musician	Example 5
1/24/2011 19:28:35	41	1	4	4	3	5	professional musician	Example 5
1/24/2011 19:46:11	50	2	4	5	3	5	non-musician	Example 3
1/24/2011 19:51:12	42	1	1	2	5	5	non-professional musician	Example 5
1/24/2011 20:51:56	57	2	5	4	2	4	non-musician, but musically oriented professional musician	Example 5
1/24/2011 21:33:14	55	1	1	3	1	4	drummer	Example 5
1/24/2011 22:02:26	44	4	1	5	3	5	non-musician	Example 3
1/25/2011 3:25:13	29	3	5	4	2	3	sound engineer	Example 2
1/25/2011 6:32:22	24	2	5	4	3	5	Amateur musician, live audio engineer	Example 5
1/25/2011 6:51:08	61	5	3	3	2	3	non-musician	Example 1
1/25/2011 9:29:50	29	2	5	2	4	3	Musician	Example 2
1/25/2011 10:29:56	29	2	3	3	1	4	nope	Example 4
1/25/2011 10:36:02	26	3	1	3	4	3	Pro musician. I just used BFD for the first time a couple weeks ago, but I feel like I remember exactly how all the BFD rooms sounded and that I can pinpoin them where they exist in this.	Example 4
1/25/2011 11:15:13	44	4	5	5	2	5	non-musician	Example 2
1/25/2011 11:40:42	29	1	4	5	3	3	pro	Example 3
1/25/2011 12:09:13	34	2	1	3	2	3	non-musician	Example 5
1/25/2011 15:02:13	61	5	4	4	4	4	non-musician	Example 4
1/25/2011 15:19:44	35	1	1	3	2	3	pro	Example 3
1/25/2011 15:53:40	53	2	5	4	1	5	non-musician	Example 2
1/25/2011 16:16:59	32	2	4	4	1	4	professional	Example 5
1/25/2011 16:30:34	25	1	4	2	2	5	Musician.	Example 5

Timestamp	Age	Musical Example 1	Musical Example 2	Musical Example 3	Musical Example 4	Musical Example 5	musician, non-musician, or student?	Which example did you prefer?
1/24/2011 8:41:48	25	3	4	5	4	4	Professional	Example 3
1/24/2011 9:13:04	28	2	5	5	1	3	Professional musician	Example 2
1/24/2011 9:38:31	48	3	4	4	3	5	non-musician	Example 3
1/24/2011 9:42:10	48	2	5	5	2	4	amateur musician	Example 2
1/24/2011 9:50:36	42	3	5	4	4	3	non-musician	Example 2
1/24/2011 9:59:52	36	1	4	3	5	2	non musician	Example 4
1/24/2011 10:16:35	28	3	5	3	2	4	non-musician Bachelor's of Music in Performance and music technology minor. So, professional musician	Example 3
1/24/2011 10:34:52	22 years old	3	5	4	4	3	/ student.	Example 2
1/24/2011 10:49:13	48	5	5	5	5	5	no	Example 4
1/24/2011 11:19:12	29 :(	2	3	5	2	3	non-musician Professional Musician, Certified ProTools 8HD, Certified Avid Live Systems, DBX	Example 3
1/24/2011 12:14:51	19	1	4	2	1	5	Certified	Example 5
1/24/2011 12:22:54	47	2	2	2	1	3	professional musician	Example 5
1/24/2011 12:29:08	33	2	3	3	4	1	non-musician	Example 4
1/24/2011 12:31:56	46	3	4	5	4	4	musician	Example 4
1/24/2011 14:15:19	21	3	4	3	2	5	Student/Professional I am a paid music	Example 5
1/24/2011 15:02:48	29	2	4	4	5	5	director at a church. I'm an amateur	Example 5
1/24/2011 15:15:27	29	1	4	4	2	4	musician.	Example 3
1/24/2011 15:16:40	27	4	3	2	1	2	Hobbyist	Example 1
1/24/2011 15:36:51	26	3	4	4	3	5	Professional	Example 3
1/24/2011 15:53:39	23	1	3	4	3	5	Musician hobby semi pro	Example 5
1/24/2011 16:04:20	41	2	5	5	3	5	musician	Example 3
1/24/2011 16:30:58	35	4	3	3	4	5	Musician.	Example 5
1/24/2011 16:54:53	42	1	1	1	1	1	Pro yes. all the snares sound like sample replacements. the other kit instruments sound real/ fake to varying degrees. example 2 is obviously programmed, but the samples are very well recorded in the first place, so i guess	Example 2
1/24/2011 17:08:36	35	2	3	3	1	3	that's my favorite!	Example 2
1/24/2011 17:11:10	30	2	3	5	2	5	professional musician	Example 2

Timestamp	Age	Musical Example 1	Musical Example 2	Musical Example 3	Musical Example 4	Musical Example 5	Are you a professional musician, non-musician, or student?	Which example did you prefer?
1/25/2011 18:11:20	43	3	4	4	3	4	Professional musician	Example 2
1/25/2011 18:12:09	36	4	5	4	3	4	non-musician	Example 2
1/25/2011 18:13:59	32	1	4	3	4	5	professional musician 15 years as a giging	Example 2
1/25/2011 18:33:28	37	5	5	5	5	5	musician. Bachelor's Degree in	Example 5
1/25/2011 19:05:15	42 years old	2	4	5	2	5	Music Performance	Example 5
1/25/2011 20:12:19	42	3	4	4	5	5	musician Non professional	Example 3
1/25/2011 20:17:44	33	2	4	5	2	4	Musician	Example 3
1/25/2011 22:38:39	34	1	3	4	2	5	non muscian Retired musician, semi-professional student, part-time	Example 5
1/25/2011 22:43:05	25	1	5	1	3	5	alligator wrestler	Example 2
1/26/2011 9:02:05	37	2	4	2	3	3	Pro	Example 2
1/26/2011 9:14:09	34	2	5	3	3	4	hobbyist musician I am a teacher and a	Example 5
1/26/2011 9:14:47	32	4	5	3	2	2	grad student Ex-professional	Example 2
1/26/2011 9:35:33	59	2	3	2	4	5	recording engineer	Example 5
1/26/2011 10:07:33	41	4	5	3	5	4	non musician real fake fake real fake	Example 4
1/26/2011 10:31:11	0	5	1	1	5	1		Example 2
1/26/2011 10:33:33	42	2	5	2	1	5	pro musician	Example 5
1/26/2011 10:35:35	48	3	2	3	4	3	non musician trained musician but not as primary source	Example 5
1/26/2011 11:09:02	39	2	4	4	4	4	of income	Example 3
1/26/2011 11:24:41	31	4	5	4	2	4	Engineer/musician	Example 2
1/26/2011 11:32:37	25	3	4	4	1	5	Student	Example 5
1/26/2011 11:34:25	33	3	3	4	5	4	pro	Example 5
1/26/2011 11:40:30	33	1	3	4	2	5	professional musician	Example 3
1/26/2011 12:22:15	35	1	1	1	1	1	pro	Example 1
1/26/2011 12:44:18	57	4	5	5	4	4	Music Educator	Example 1
1/26/2011 12:53:48	38	2	2	3	3	4	yes	Example 5
1/26/2011 13:06:04	63	3	4	4	4	4	Professional Musician	Example 4
1/26/2011 14:55:08	31	1	5	4	2	3	semi pro musician Semi-professional	Example 3
1/26/2011 19:32:11	27	3	4	2	1	4	musician	Example 2
1/27/2011 11:33:44	36	5	3	4	4	3	Pro musician	Example 1
1/27/2011 13:25:08	22	2	5	4	3	2	non-musician None of the above? Definitely musician. Semi-professional	Example 2

Timestamp	Age	Musical Example 1	Musical Example 2	Musical Example 3	Musical Example 4	Musical Example 5	Are you a professional musician, non-musician, or student?	Which example did you prefer?
1/27/2011 17:28:30	32	2	5	4	4	3	non-musician	Example 3
1/27/2011 18:03:27	28	3	4	4	5	3	Amateur musician and student	Example 4
1/27/2011 18:54:46	29	1	5	4	4	4	non-musician	Example 2
1/27/2011 19:27:58	33	2	4	3	4	5	Amateur musician	Example 5
1/27/2011 19:28:40	30	2	4	3	2	3	pro	Example 3
1/27/2011 20:20:51	44	2	5	2	2	3	Non musician	Example 2
1/27/2011 21:46:54	29	2	4	4	3	5	musician	Example 5
1/27/2011 22:18:21	36	3	4	4	3	5	Professional Musician	Example 5
1/28/2011 10:04:59	44	3	5	4	5	5	Professional	Example 5
1/28/2011 10:06:31	54	5	5	5	4	4	Professional drummer. 44 years.	Example 2
1/28/2011 12:07:15	32	2	5	5	3	5	Student	Example 2
1/28/2011 19:38:24	23	1	5	4	2	4	A musician, but not quite a professional musician.	Example 5
1/28/2011 20:23:26	35	3	5	4	2	4	non-musician	Example 2