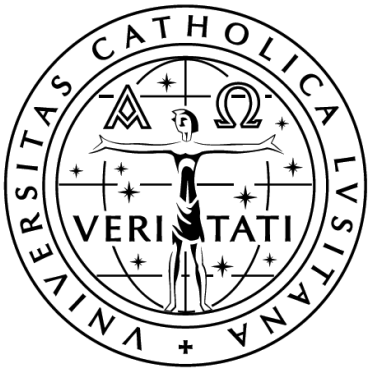

UNIVERSIDADE CATÓLICA PORTUGUESA

DESIGNING INSTRUMENTS TOWARDS NETWORKED MUSIC PRACTICES

Tese apresentada à Universidade Católica Portuguesa

para obtenção do grau de doutor em Ciência e Tecnologia das Artes, com

especialização em Informática Musical

Por

Nicolas Alexander Makelberge

(Escolas des Artes, Universidade Católica Portuguesa)

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Abstract

It is commonly noted in New Interfaces for Musical Expression (NIME) research that few of these make it to the mainstream and are adopted by the general public. Some research in Sound and Music Computing (SMC) suggests that the lack of humanistic research guiding technological development may be one of the causes. Many new technologies are invented, however without real aim else than for technical innovation, great products however emphasize the user-friendliness, user involvement in the design process or User-Centred Design (UCD), that seek to guarantee that innovation address real, existing needs among users. Such an approach includes not only traditionally quantifiable usability goals, but also qualitative, psychological, philosophical and musical such. The latter approach has come to be called *experience* design, while the former is referred to as *interaction* design. Although the Human Computer Interaction (HCI) community in general has recognized the significance of qualitative needs and experience design, NIME has been slower to adopt this new paradigm. This thesis therefore attempts to investigate its relevance in NIME, and specifically Computer Supported Cooperative Work (CSCW) for music applications by devising a prototype for group music action based on needs defined from pianists engaging in piano duets, one of the more common forms of group creation seen in the western musical tradition. These needs, some which are socio-emotional in nature, are addressed through our prototype although in the context of computers and global networks by allowing for composers from all over the world to submit music to a group concert on a Yamaha Disklavier in location in Porto, Portugal. Although this prototype is not a new gestural controller per se, and therefore not a traditional NIME, but rather a platform that interfaces groups of composers with a remote audience, the aim of this research is on investigating how contextual parameters like *venue*,

audience, joint concert and *technologies* impact the overall user experience of such a system. The results of this research has been important not only in understanding the processes, services, events or environments in which NIME's operate, but also understanding reciprocity, creativity, experience design in Networked Music practices.

Resumo

É de conhecimento generalizado que na área de investigação em novos interfaces para expressão musical (NIME - New Interfaces for Musical Expression), poucos dos resultantes dispositivos acabam por ser popularizados e adoptados pelo grande público. Algum do trabalho em computação sonora e musical (SMC- Sound and Music Computing) sugere que uma das causas para esta dificuldade, reside numalacuna ao nível da investigação dos comportamentos humanos como linha orientadora para os desenvolvimentos tecnológicos. Muitos dos desenvolvimentos tecnológicos são conduzidos sem um real objectivo, para além da inovação tecnológica, resultando em excelentes produtos, mas sem qualquer enfâse na usabilidade humana ou envolvimento do utilizador no processo de Design (UCD- User Centered Design), no sentido de garantir que a inovação atende a necessidades reais dos utilizadores finais. Esta estratégia implica, não só objectivos quantitativos tradicionais de usabilidade, mas também princípios qualitativos, fisiológicos, psicológicos e musicológicos. Esta ultima abordagem é atualmente reconhecida como Design de Experiência (Experience Design) enquanto a abordagem tradicional é vulgarmente reconhecida apenas como Design de Interação (Interaction Design). Apesar de na área Interação Homem-Computador (HCI – Human Computer Interaction) as necessidades qualitativas no design de experiência ser amplamente reconhecido em termos do seu significado e aplicabilidade, a comunidade NIME tem sido mais lenta em adoptar este novo paradigma. Neste sentido, esta Tese procura investigar a relevância em NIME, especificamente nu subtópico do trabalho cooperativo suportado por Computadores (CSCW – Computer Supported Cooperative Work), para aplicações musicais, através do desenvolvimento de um protótipo de um sistema que suporta ações musicais coletivas, baseado nas necessidades especificas de

Pianistas em duetos de Piano, uma das formas mais comuns de criação musical em grupo popularizada na tradição musical ocidental. Estes requisitos, alguns sócio-emocionais na sua natureza, são atendidos através do protótipo, neste caso aplicado ao contexto informático e da rede de comunicações global, permitindo a compositores de todo o mundo submeterem a sua música para um concerto de piano em grupo num piano acústico Yamaha Disklavier, localizado fisicamente na cidade do Porto, Portugal. Este protótipo não introduz um novo controlador em si mesmo, e consequentemente não está alinhado com as típicas propostas de NIME. Trata-se sim, de uma nova plataforma de interface em grupo para compositores com uma audiência remota, enquadrado com objectivos de experimentação e investigação sobre o impacto de diversos parâmetros, tais como o espaço performativo, as audiências, concertos colaborativos e tecnologias em termos do sistema global. O resultado deste processo de investigação foi relevante, não só para compreender os processos, serviços, eventos ou ambiente em que os NIME podem operar, mas também para melhor perceber a reciprocidade, criatividade e design de experiencia nas práticas musicais em rede.

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Table of contents

Appendix A

Published Work by the Author

Appendix B

Data of User Comments

Appendix C

Data DVD With Audio Recordings

List of figures

Chapter 1

Introduction

Music is a collective venture, not only because most of it is produced by groups of people, but also because music made in solitude, the melodies, sounds, rhythms and beats etc. is something grounded in our collective musical culture. Henceforth our most recent technological blessings in Information and Communication Technology (ICT) have been applied to support this collective activity, in the domain of supporting musical group activities of all kinds.

First, starting of as local networks in the ‘70s with quite primitive machines according to today’s standard, however it wasn’t long after the distribution of the Personal Computer (PC) and worldwide computer networks, the Internet, that what was begun as a explorations among tech-savvy musicians and computer scientists became a way of music-making of the general public. Still in its infancy, Networked Music as the area came to be called, have produced some significant technologies that do not only offer new ways for creators to produce works of art in group, but also produce works that hold interesting value in both concept and aesthetics. Networked music research has since then emerged as a cornerstone of Sound and SMC research and of much future promise (Bernardini, De Poli, Serra, Leman, & Widmer, 2007).

1.1 Motivation

The motivation behind this thesis was founded on exploring how a user driven design approach as opposed to technologically driven could be utilized in the design of Networked Music systems. Such an approach would naturally have to take goals and

motivations of users into account and designing thereafter which is traditionally referred to as User Centred Design and in our case specifically *experience design,* a version of UCD that addresses various psychological needs users have that motivates them to interact with new technologies. This type of approach is often seen as a compliment to the more traditional usability, or *interaction* design that focuses on quantifiable, task-focused investigations. Our research, attempts to introduce experience design thinking and methodology in NIME, more specifically in Networked Music and CSCW for music applications where users needs for collective action, so called socio-emotional needs are identified by research of piano duets, and subsequently addressed in a prototype system we have build called Perfect Take (PT). In doing so we hope to investigate how *experience design* fits in the domain of Networked Music and in the process of building systems that support collective musical activities.

1.2 Objective of this dissertation

The objective of this dissertation is to contribute to the field of Computer - Supported Cooperative Work (CSCW) for Music Application, and explore the hypothesis if a jointly produced concert rendered and recorded on a Yamaha Disklavier in a remote venue is an adequate, and enjoyable vehicle for the collective recording and dissemination of musical works. More specifically, it is focused on investigating what role the *venue*, *audience, joint concert* and *technologies* relate to the needs, some of which are socio-emotional, that composers might have in using the system, and how these contribute to the overall user experience.

1.3 Structure of this dissertation

The dissertation starts off by looking into the history of music and computer networks, followed by various models of classifications of systems devised for group music creation over networks. Later we explore some contemporary projects that share some similarities with our own system as we enter into creativity in contemporary music and how our system relates to this many times elusive phenomena. After that, we go into defining and exploring methods of experience design and how we may approach this topic in the context of NIME's to finally get into the design and implementation of our prototype PT, and subsequent evaluation and results.

Chapter 2

The beginnings

2.1 The social of music

Music is traditionally considered an innately social phenomenon like any art, not only because we enjoy making music together but also because when making music in solitude, what we express is directed to others within our cultural framework.

"*Art is the social within us, and even if its action is performed by a single individual it does not mean that its essence is individual* [...] *Art is the social technique of emotion, a tool of society which brings the most intimate and personal aspects of our being into the circle of social"* (Vygotsky, 1971)

This might be why music is often referred to as a language, or the language of emotion or "language-like" (Kivy, 2007), a way of communicating, of course inherently social. The real value of communicating facts or emotions we come across in life is that enables us to maintain a culture by which we transact, discuss, define, and interpret social behaviour in society (Casson, 1999), which clearly comes with a set of adaptive advantages to us as a species. Likewise musical culture consists of an ongoing perpetual exchange of sounds, styles, musical ideas and forms (Toynbee, 2000, p. xiv), an exchange that traditionally was bound in place and a time, slowly moving from person to person, culture to culture. Before the industrial revolution, the transmission of music was through live performance, due to an absence of mass media such as the radio and the phonograph; children of good families wherefore

often learned how to play the piano for the enjoyment of the family (McCutcheon, 2001). However, with the industrialism came technologies such as the tape recorder and the phonograph, allowing for mechanical reproduction of music (Benjamin, 1969) an evolution that not only greatly supported the dissemination of music, but also changed the *value* of music from what was considered a live event to the actual reproduction and the infrastructures of distribution. In today's information society with torrent, peer-to-peer software, mp3, and streaming services of music, reproduction and transmission of cultural ideas has moved beyond the mechanical into data-replication and live streaming of data (see. Youtube, Spotify, Flickr) that feed our senses from all over the world. In this scenario we engage in the world of musical ideas with an augmented sense of vision and hearing by means of personal computers and worldwide networks, an augmentation and its proportions that media theorist Marshall McLuhan argued affected us more than the very message they transmitted (McLuhan & Fiore, 1967). That being the case or not, the consequence however has been that distance is shrunk in both space and time bringing remote elements to our window to the world (the PC), including musical ideas from distant places in time and space to our doorstep. This matter of fact has naturally provided new possibilities in this exchange that is the very thing that bring forth musical works that are novel, surprising and valuable - or considered creative (Boden, 2009).

The way we collectively bring forth musical works in discourse over the Internet often differ in reciprocity (Tanaka, 2006) or interconnectedness (Weinberg G. , 2003), some works emerge through intensely reciprocal musical activity, while others are not reciprocal at all, but still include the work of many. This might seem contradictive, however considering activities such as sampling, remix or "mash-up" cultures, which all can be considered collective artworks; they lack reciprocity, often

with single individuals at the helm of creation. Previous research therefore has suggested the value of differentiating between various ways of collective music making of varying reciprocity (Makelberge, 2012), as it deepens our understanding of collective music action over networks.

2.2 Music over networks, the beginnings

"*All Music Is Networked. You can think about an Orchestra as client-server network, where a conductor is 'serving' visual information to the 'client' musicians, or a peer-to-peer networking model in an improvising Jazz Combo, where there is no one directing, and the musicians are all interacting, so, any performance context we can think of in some way there is a network connecting the performers* [...]. *Networked Music with capital N and capital M (the kind we are talking about) is about performance situations where traditional aural and visual connections between participants are augmented, mediated or replaced by electronically-controlled connections*." (From Jason Freeman's lecture opening at the 1st Networked Music Workshop during the International Computer Music Conference 2005)

Technological breakthroughs have continuously been a contributor to not only how we make music in group, but also the changing aesthetics of music throughout the ages. New instruments are forged, offering novel, enhanced ways of not only producing and shaping sound but also assembling sounds into music. This not only affects composition, but also performance and how works of music are interpreted on the receiving end of the spectrum among audience and critics. In the same manner, computer networks empower people to join together in making music, to engage in synchronous and asynchronous transaction of musical style, sounds, ideas and forms.

This new medium facilitates a musical communication with a set of unique characteristics, and offer new prospects in supporting creativity in the creation of music. These unique affordances can be seen emerging as early as the ‘50s and is a drive towards new ways to interconnect between musicians, formulated through nascent technologies like the radio, microphones, signal processing, and associated practices. Some early attempts of exploring new, creative interconnections and “networking” between musicians can be seen in composers John Cage and Karlheinz Stockhausen which both explored the possibilities by assigning performers new roles manipulating unorthodox facets of sounds in performances.

2.2.1 John Cage

John Cage was one of the first to realise the potential in exploring more elaborate interdependent musical procedures, rules and processes than what the classical orchestra offered, through the recently invented commercial transistor radio, treating it as a musical instrument. Cage’s compositions explored evolving and dynamic musical contexts by external entities (audio steams from radio stations) through transistor radios, thus providing a first basic concept of a process-centred, decentralized musical setting. The first electronic Interconnected Musical Networks (IMN), as seen in Gil Weinberg’s research in the area of local networks could therefore be said to be Cage’s 1951 “Imaginary Landscape No. 4” for twelve radios played by twenty-four performers. The score of this composition provide performers with information regarding the tuning and volume settings, although without information whether a station exists at that certain dial setting, or eve less what might

be broadcasted at particular stations. Inspired by the I-Ching[1], Cage explored chance procedures by allowing performers to only control certain prescribed elements of the composition, while technology and chance all together contributed the musical result. Cage, as a composer therefore resorted to providing the setting and context through his guidelines of radio dial settings. Cages' radiobroadcast in Speech (1955) for five radios and a news reader and Music Walk (1958) for one or more pianists, radios and phonographs, are further experimentations with these emerging forms of musical interdependence, and new roles of performers that new technologies afforded, demoting the composer from someone brining regimen out of chaos to letting processes take care of themselves, much like biological systems, or ecosystems where life "*act on its own accord*" (Cage, 1961).

2.2.2 Stockhausen's microphonie I

Similar to "Imaginary Landscape No. 4", "Mikrophonie I" by German composer Stockhausen displays the same thinking in many ways similar to Cage. Through a tam-tam providing the basic sound material, six performers distributed in manipulating either two microphones, two filters and potentiometers where the sounds of the tam-tam pass through filters that are manipulated and finally amplified. In this sense, the performance process and process of composition is merged by the sound of the tam-tam being shaped in real-time. In Microphonie I, pitch as texture allows to be changed, non-pitched sounds may be turned into pitched, and the electronic processes may emphasize or de-emphasize similarity and differences between musical gestures. The sound world that Microphonie thus allows for is not

[1] A Chinese book of oracles

just the additive combination of sounds generated by the individual players as we see in traditional orchestration (Wessel, 1991), but examines some of the unique character of these new, decentralised ways of interdependencies afforded by new audio technologies that we take for granted today, where the active use of these is a base concept in the performance of the piece. As Stockhausen said concerning this approach in Microphonie I:

"*normally inaudible vibrations* [...] *are made audible by an active process of sound detection (comparable to the auscultation of a body by a physician); the microphone is used actively as a musical instrument, in contrast to its former passive function of reproducing sounds as faithfully as possible*" (Stockhausen, 1965).

2.2.3 The league and the hub

With the advent of the personal computer came new and interesting attempts at exploring musical interdependence through various new and budding network topologies employed locally. 1976 Commodore KIM-1 was one of the first commercial computers employed for various network interaction in music. By networking their computers, The League of Automatic Music Composers (Brown & Bischoff, 2005), a group of musicians from Oakland, California could send and receive data from each other, creating and experimenting with intricate musical interconnections. They named this form of musical performance "Network Computer Music". In their 1978 performance the group set up a synchronous network, mapping various elements of music from one computer to generate or modify other elements from another computer. The League evolved into "The Hub" in 1986, and employed the MIDI protocol to have more precise communication schemes and more central

control exchanging only musical control messages and not the audio signals themselves. One of their projects include Waxlips (1991) which explored more hierarchically social structures of musical groups, and also ventured into exploring networks role in remote collaboration and audience participation, naturally hampered by that times nascent and unsophisticated (by our standard) technology. The league of automatic composers are traditionally credited to being one of the first at attempting to jointly create an musical artwork by the means of computers and network technology, and explore its interactive possibilities.

2.2.4 Along came the Internet

At the end of the ‘90s computers had gained significantly in performance and storage capacity so that the hard disks slowly took over and replaced analogue forms of recording such as tape. The hard-drive, together with the advent of professional sound cards launched the PC as the central tool for music producers aiding in composing, recording, editing and mastering music. Through this development, users became less and less hardware dependent thanks to Digital Audio Workstations (DAW) such as Cubase and Digidesign’s Pro Tools that incorporated more and more features and tools traditionally only found in professional hardware studios.

Along with the development of personal computing, networks and computer based communication gained more and more attention among computer aficionados. In 1969, the Advanced Research Projects Agency Network (ARPANET) arrived, which was initially intended for military use within the US ministry of defence by connecting a set of research institutes and universities. The Arpanet is the ancestor of what today is the Internet, which originated as a text based platform for the exchange of scientific data within academia. This potent combination, of the computer for

producing, manipulating and storing sound on one side and worldwide networks afforded by the Internet on the other, set the ideal scenario for the multitude of ways we together engage in making music today.

2.3 Systematic classifications

At present, research has come a long way with a multitude of technologies developed for communal creation of music through network technology. Initial systematic classification of these different networked music systems, the reader can refer to Duckworth (Duckworth, 1999) and Gil Weinberg in (Weinberg G. , 2002) (Weinberg G. , 2005) that describe topologies depending on the social organization of these networks and on the nature (centralized-decentralized) of their connections. (Föllmer, 2002) (Tanzi, 2001) and (Barbosa Á. , 2003), the latter proposing a spatial-temporal classification (Figure 1.) that categorizes systems in terms of the locations of the performers (local vs. remote), the temporal quality of the interaction (real-time vs. non real-time). Systems are classified into *Co-located Musical Networks, Music Composition Support Systems, Remote Music Performance Systems* and *Shared Sonic Environments*. All authors however address the subject from different perspectives, topics such as the goals and the motivations, the technical constraints, as well as difference in perspectives, social and topological implications of both online and local musical networks, also proposing taxonomies and describing ways of implementations. All these authors also tend to address the peculiarities brought about by the displaced medium, such as time latency or physical distribution's affect on group action in music.

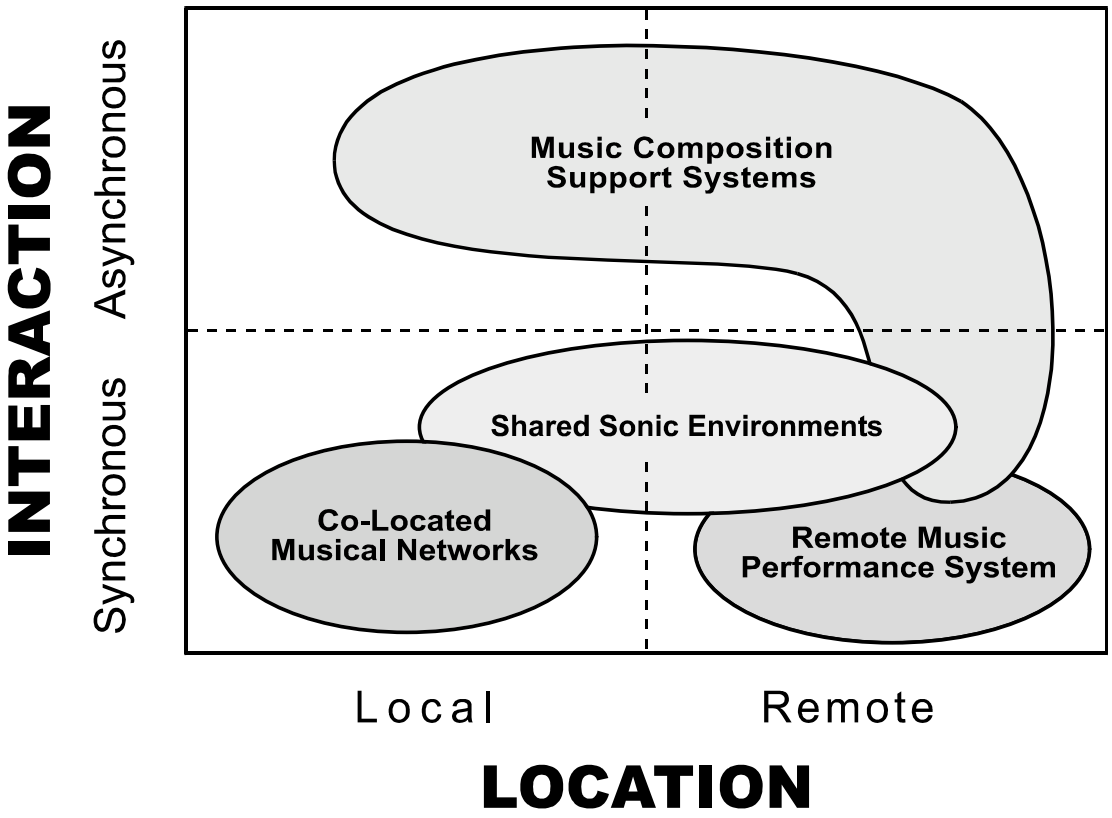

Figure 1. CSCW for music applications classification space.

2.3.1 Co-located musical networks

Co-located musical networks are real-time systems as part of organized events for groups of performers, in the same venue, on a set of music instruments. They provide interdependency of various elements of sound and music and are supported by a fast local computer network. Some work included in this category was by Gil Weinberg at Tod Machover's HyperInstruments Group at the Massachusetts Institute of Technology's (MIT) Media Lab, which has resulted in several examples of co-located musical networks, or Interconnected Musical Networks (IMN's an acronym coined by Weinberg of these types of systems). Some of this work includes **Fireflies** (Weinberg, Lakner, & Jay, 2000), the **Squeezables** (Weinberg & Gan, 2001), the **Beatbugs** (Weinberg, Aimi, & Jennings, 2002) and the ReacTable (Jordà, Kaltenbrunner, Geiger, & Bencina, 2005)

2.3.2 Music Composition Support Systems

Music Composition Support Systems are employed to assist what resembles more traditional forms of music composition and production, both oriented towards a written music support or music production based on multi-track and non-linear recording processes. These systems allow for users to be displaced geographically and in time. Examples include Faust Music Online (FMOL) (Jordà, 1999) an Internet-based music composition system (described in more detail in Chapter 3, Section 3.1.3), originally intended to allow users to participate in the creation of the music for a Catalan theatre group, or the online recording studio Kompoz[2] which is an online platform for crowd-sourcing music creation from song conception to recording, mixing and publishing. Kompoz can be seen as an online social network designed for musicians to create songs with others from around the world.

2.3.3 Remote Music Performance Systems

Remote music performance systems provide organized events for groups of remote performers/users, displaced in space but synchronous in time, improvising and interacting on a set of music instruments[3]. As a consequence this scenario is naturally affected by network latency. Work in this area includes early attempts such as the Internet-based music performance at the 2nd Association for Computing Machinery (ACM) Conference on Multimedia Computing in San Francisco, USA in 1994 where a group created and synchronized three real-time streams of music from different Internet hosts. Though the audio quality reached an acceptable level, it was recorded

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[2] http://www.kompoz.com/

[3] Even "Tele-presence" (remote unilateral participation) falls under this category of applications.

that it proved difficult for the players to perform with delays in the order of 200 ms. (Schooler, 1993) Other work includes that of Chris Chafe at Stanford's Center for Computer Research in Music and Acoustics (CCRMA) whom through the "SoundWire" Project (Chafe, 2012) take advantage of the implementation of Internet2 for performing several real-time audio streaming acts, including that of the "Pacific Rim of Wire", a multi-ensemble networked concert across a 6000 mile span of network with Peking University in China and involved resolving issues such as incompatible networking address protocols to the synchronization of performers, human and computer (Caceres, Hamilton, Iyer, Chafe, & Wang, 2008). Further research involves that of Alexander Carôt whom divides various modes of Networked Music Performance relative to latency, or more specifically the Ensemble Delay Acceptance Limit (EDAL), which is the "collective latency acceptance limit" that defines the ideal conditions musicians can perform under (Renaud, Carôt, & and Rebelo, 2007) (Carôt, 2009). These forms of performance are also what is commonly referred to as "telematic music" (Oliveros, Weaver, Dresser, Pitcher, Braasch, & Chafe, 2009).

The unavoidable asynchronousity induced by network latency among people collaborating over the internet has spawned some researchers to consider this temporal characteristic of the medium as a welcomed element, much like composers of sacred music in the Medieval era were writing for cathedrals utilizing the long reverberation times to mask secular melodies within the long, gradually moving lines of the "cantus firmus" (Grout & Palisca, 2000). Music made through networks therefore, likewise inhibit a space and the time characteristic of the network infrastructure defines the musical qualities of the networked medium. In this way,

latency becomes, some say, the *acoustic of the network*, to be explored and made use of, just as any other physical characteristics of a space. (Tanaka A. , 2003).

2.3.4 Shared Sonic Environments

Shared Sonic Environments is a class of applications that explores the distributed nature of the Internet, and is not necessarily oriented towards any events of limited time and place. These systems are mainly for synchronous improvisation since they provides simple and effective ways for simultaneous collective sonic expression that do not require previous musical knowledge from participants. Examples of work done in this are is the Public Sound Objects (PSO) (Barbosa & Kaltenbrunner, 2002) (Barbosa Á. , 2008) which is an experimental web-based "Shared Sonic Environment" available to the general public and which requires no previous music knowledge to operate. Users join a collaborative performance through a "Bouncing Ball" Java Interface and by manipulating various Sound Objects. Another system similar to the PSO is that of the Daisyphone (Bryan-Kinns, 2004) that supports remote music creation through a shared interface where participants collaboratively edit a short loop of music in a circular fashion.

General classifications of all these systems have been provided in various ways by several authors (Barbosa Á. , 2008) (Blaine & Fels, 2003) (Tanzi, 2001) (Föllmer, 2002) (Renaud, Carôt, & and Rebelo, 2007) (Carôt, 2009).

2.4 Musical collaboration, cooperation, collective creation

When classifying various modes of making music together over networks, we commonly refer to the spatial-temporal mode of interaction as we saw in the previous

examples. However, there are other forms of classification that can be useful in shedding insight to these activities, one such involves the discrepancies between the terms collaboration, cooperation or collective creation, three terms used interchangeably in much Networked Music research (Blaine & Fels, 2003) (Weinberg G. , 2003) (Jordà, 2005) (Barbosa Á. , 2008). So far, these terms have not been used explicitly to differentiate between various systems within the domain, despite its relevance. Instead, other forms of classification have been favoured depending on the intent of the research.

First off, as an attempt at categorization, what constitutes collaboration and sets it apart from any individual achievements is interdependence (Weinberg G. , 2003) or reciprocity (Tanaka A. , 2006) among involved parties. Approaching networked music from the point of reciprocity however, we will see that the three – collaboration, cooperation and collective creation, all spread out along an axis of less to more intense reciprocity (Figure 2.).

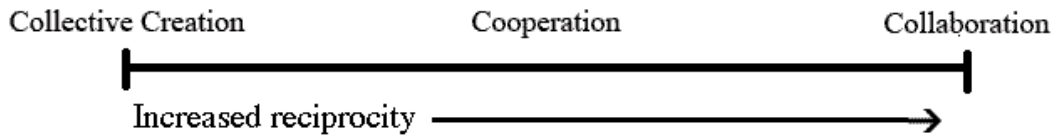

Figure 2. Collective Creation, Cooperation and Collaboration on an axis of reciprocity

Distinct boundaries of these are difficult, if not impossible to make out, however, identifying a distinction between these is possible. As we all know, the Internet provides a space where we may communicate in varying reciprocal intensity; products out of highly reciprocal interactions are considered collaborative, as defined by Roschelle and Teasley:

"*Collaboration is a process by which individuals negotiate and share meanings relevant to the problem-solving task at hand* [...] *Collaboration is a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem*." (Roschelle & Teasley, 1995)

While collaboration is a coordinated and synchronous activity, cooperation is an activity in which partners split the work, solve sub-tasks individually and then assemble the partial results into the final output (Dillenbourg, 1999) and thus shows less reciprocity. Therefore, the more collaborative an activity is, the more intensely reciprocal (or interdependent) it is. The implications for networked music are that "remote music performance systems" (Barbosa Á. , 2008), such as a synchronous networked jazz improvisation by remotely interacting instrumentalists, could be considered collaboration due to its reciprocal intensity attempting to construct and maintain a shared conception of a problem, while the asynchronous co-authoring of a MIDI-file over email is rather more like cooperation due to its less intense reciprocity.

The prototype system PT, developed as part of this thesis where composers from all over the world add their works to a shared concert program in form of a Music Instrument Digital Interface (MIDI) -file, to have their music rendered and recorded on a Yamaha Disklavier Piano for an audience, and subsequently shared back to them over the Internet under a Creative Commons[4] licence (More about this in Chapter 4, section 4.3.7), would in this context be considered collective creation

[4] http://creativecommons.org

(the less reciprocal forms of communal action in music) rather than cooperation or collaboration.

Chapter 3

Related Work

Previous work relating to PT can be classified into three groups. First are "compositional support systems" that similarly to PT in that they share the remote and asynchronous nature of making an artwork, in our case a concert program performed and recorded for an audience in a remote location. Secondly we have what can be called "networked reverberant spaces" which are systems that allow for sound artists to access a remote venue to record their sound, utilizing the unique properties and acoustics of places though networks. Thirdly you have "tele-presence" and "tele-robotics", where sound artists utilize technologies that mimic human presence and performers in the realization of their work or performance. Although our system in is different from these systems, they share many similarities to these as well.

3.1 Compositional Support Systems

As the concert program of PT is seen as a jointly created artwork, it can be considered a user generated "composition", much like a Disc Jockey (DJ) - set, or a mix tape where composers sequentially add their contributions, remotely. Despite individual contributions not being layered on top of each other, like in most compositional support systems, they share the remote and asynchronous nature of making an artwork in a group. First off is the ResRocket surfer virtual studio software that emerged in the '90s.

3.1.1 ResRocket Surfer

One of the first systems along the “virtual studio” approach was the ResRocket Surfer (Figure 3.), a free application, released in 1994 (Barbosa Á. , 2008, p. 45), which had communities of users creating music together over the Internet. The system allowed both musicians and audience to organize what was called “Virtual Studio” groups, laying down MIDI-tracks in compositions according to some permissions defined by the creators of the various sessions. The ResRocket Software operated both in synchronous or asynchronous mode. The company that developed this software, Rocket Networks, concurrently launched the Rocket Power Audio Software intended for professional recording, and supported both digital audio and MIDI. This software provided a platform for the creation of “Virtual Work Places” synchronised by a central server. Rocket Power Audio became the preferred choice in the industry providing remote collaboration on digital recording software packages and supported by Protools, Logic Audio and Cubase Virtual Studio Technology (VST). Despite the initial success, the Rocket Networks Company ceased activities in 2000. Since then similar system such as the **TONOS-TC8** was commercially introduced (Barbosa Á. , 2008, p. 47).

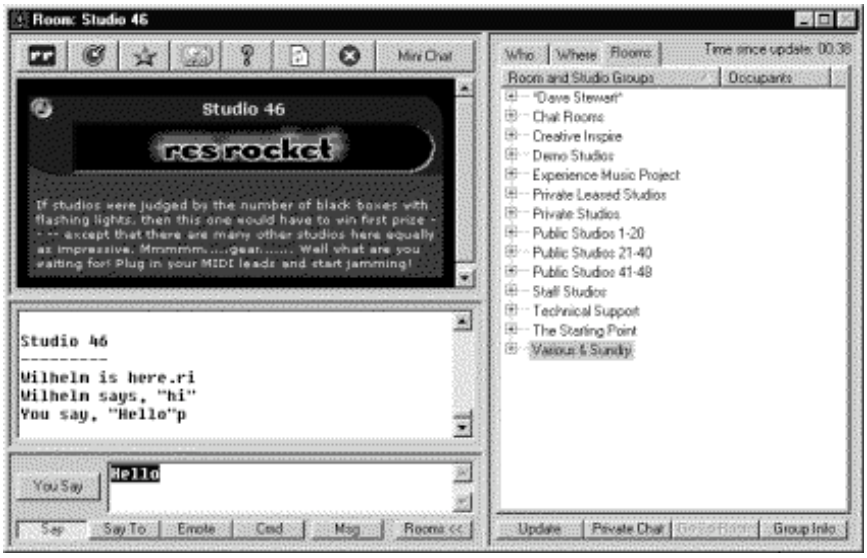

Figure 3. Screen Shots of the ResRocket Software showing a structured list of ongoing sessions a multi-track project view with individual tracks recorded by different users.

3.1.2 eJamming

eJamming[5] (Figure 4.), is an application released in 2008 by Alan Gluckman, Bill Redman and Gail Kantor . This application can be considered a multi-user audio platform where musicians may search for collaborators according to instrument preference, skills, abilities and musical styles through its database structure. It also allows for building online groups with players they may run into in sessions that are open fore everyone. eJamming also provides online forums, where musicians may share experiences by uploading media and trouble-shooting problems with peers. While eJamming is not the first network platform to provide a user-driven community, it uses peer2peer architecture and UDP packet sending to provide what has been said to be a less strenuous user experience by transmitting 44.1 kHz, 16kbt WAV files with unperceivable latency (11ms) for Wide Area Network (WAN) connectivity. All control parameters are contained within the client software,

[5] http://www.ejamming.com/

equipped with two modes, JAM and Virtual Recording Studio (VRS). The first, JAM facilitates up to four players with a manually adjustable buffer for long-distance collaborations, and the second, VRS, provides online multi-track recording. When recording in this mode, musicians may monitor their performance in full synchronization with previous recorded tracks that are stored and available for editing via the server provided by eJamming.

Figure 4. The eJamming interface

3.1.3 FMOL

FMOL is a software application developed by Sergi Jordà back in 1997 and was commissioned by the Catalan theatre group La Fura dels Baus. FMOL has existed in various versions and has many facets to it, some which it shares with PT in the sense that they are both asynchronous compositional spaces where users submit their own audio material to create an artwork. FMOL is a self-contained electronic music instrument that spearheaded a powerful collective musical paradigm providing

collective musical opportunity to create an evolving piece of musical art. With a sound-quality of 22 KHz and a good sense of playability due to the simplified transformation algorithms from more sophisticated sound synthesis filters Jorda's approach provided a light and fast software that may run on inexpensive computers without any additional controllers except the keyboard and the mouse. Moreover, the unique "Bamboo" interface used in FMOL's, is one of the key elements to the rhythmical and melodic progressions, found in FMOL and unique to this electronic, screen-based musical instrument.

In FMOL users are able to collectively transform or even modify pieces of sound/music composed by other users, a database track all versions of evolving pieces providing a way for the co-authoring of iterated music pieces. FMOL is accessible to all since it does not require any additional hardware or specific experience in creating music; it is therefore ideally tailored for collective music activities over the Internet.

3.1.4 Freesound.org

Freesound.org[6] was a project initiated in 2004 by Bram Jhong at the Music Technology Group at the Pompeu Fabra University in Barcelona. The initial purpose of this project was to facilitate the International Computer Music Conference (ICMC) in 2005 dedicated to the topic of "free sounds". This system is made up of a participatory generated database of sounds licensed under CC. The system has various functionalities of surfing, downloading and uploading sound. Since its inception, freesound.org has become one of the leading online platforms for the sharing of sounds recorded by contributors from all over the world. Some further

[6] http://www.freesound.org

experimentation with features of the system provided what can be considered a quite unique collective sonic composition tool, the “Remix! Tree.” The basic idea to this functionality is similar to what can be seen in the iterative database of FMOL, where users download a sample, remix it, or remix a remixed sound these results will be visualized in a tree structure where remixed samples appear as branches in the tree. PT is similar to both freesound.org and the “Remix! Tree” in the sense that it provides a user-generated database of piano music open to the public to use in their own creations, remix or re-purpose.

3.1.5 ccMixter and CC-Remix

Similar to freesound.org, ccMixter[7] is a community driven music website featuring remixed music licensed under CC where visitors (more recently also including a few artists in the mainstream, from Nine Inch Nails to Radiohead) may listen to, sample, remix, or interact with music in whatever way they want. The system allows fellow members of the community to build on each other’s work by further adding instrumental or vocal tracks, remixing the material, or using it in other ways including for their own compositions (Stone, 2009). The site is created by CC for the distribution of music under the CC license and is dedicated to uploads and distribution of CC content. All uploaded material and remixes are automatically disseminated under the CC-license. On of the more salient features is the "Sample Tree", that is similar in ways to the “Remix! Tree” provided by freesound.org, where the genealogy of musical samples is tracked between complete songs from i.e. a single guitar solo to a full ensemble piece, that may be performed and produced by musicians who have

[7] http://ccmixter.org/

quite possibly never met. These musical sites explore (similarly to Flickr[8] and YouTube[9]) joint efforts and opportunities – providing platforms for collective creation and multimedia work.

CC-Remix is another networked collective music creation system that subscribes to the Creative Commons license. It can be seen as a facilitator of social creativity and allows up to four simultaneous users to engage in a process of mixing and creating music. CC-Remix allows users to take excerpts from existing songs and mix them together into new music; and in this way mimicking movements such as sampling, remix or mash-up culture (Salon, 2012). The source materials that users employ is derived from a CD published by Wired Magazine promoting Creative Commons and entailed well-known artists including Beastie Boys and David Byrne, who each published a title under CC. As neither the CC website, or the CD provides any means for the CC-type act of music creation itself. The current model remains with the assumption that most users have knowledge in music production techniques, and thus CC does no attempt at providing the tools necessary to create music, CC-Remix therefore reconciles normal, non-musician users without specialized tools, with this new mode of music making. The idea for CC-Remix was therefore to create a complete end-to-end system that entails collective action to creation to dissemination all in one application, and by doing so finding out how people listen to music and the impact network technologies has on fostering creativity in music. (Tanaka, Tokui, & Momeni, 2005)

[8] http://www.flickr.com

[9] http://www.youtube.com

3.1.6 A concert as an art object

As PT can be seen as a "compositional support system" in the sense that it provides a way for artists, distributed in time and place to collectively produce a concert together at a specific venue, it is reminiscent of ResRocket, eJamming, FMOL, freesound.org, ccMixter and CC-Remix where groups of users asynchronously and remotely create an musical work of art. Seeing a concert, or a set of musical pieces however as a work of art is reminiscent of the phenomenon of "mix-tape", a popular activity in the previous decades and goes back to at least 1963 when Philips introduced the magnetic cassette tape (Lubar, 1993). An activity that produces what many see as an artwork that demands certain skill and tact, in the words of DJ Paul D. Miller:

"*To me, the mixed tape is the ultimate example of a new art object*" (Cox & Warner, 2004, p. 352)

It is said that mix-tapes thrived in certain musical subcultures, such as the hip-hop, in which many of the best records were "not legally available" (Frith, 1986). In these subcultures, mix-tapes helped individuals develop a collective sense of identity based on shared musical interests (Hebdige, 1990).

Although the functionality of PT allows very limited means for users to modify and shape the concert (users merely submit their music and are placed in a stack to be performed, they cannot change the order, delete, edit any of the submitted material) they have little ultimate influence on how the final artwork, or concert is "composed". A scenario however can be easily envisioned where various, roles and functionality is added and experimented with based on further testing on users.

3.2 Networked reverberant spaces

As PT allows any user to access and explore the acoustics of a grand piano and the reverberant space it is placed in, naturally becoming a part of the recording, reverberation therefore will be an unmistakable part of the final quality or appearance of the musical artwork. The unique reverberation of the room acoustics of a remote and unique location is one of the central advantages of having your music recorded on the PT system, let us therefore have a closer look at this unique phenomenon.

3.2.1 Reverb

Natural reverberation is produced by sounds reflecting off surfaces. These surfaces disperse the sound, enriching it by layering the sound with its reflections. This process colours the sound to a certain extent, inducing a change in timbre. The significance of reverberation is well known to musicians who have performed the same piece of music in two separate halls. The effect the different reverberant characteristics of the two spaces have may influence the performance in many ways. For example, a tempo adjustment selected to articulate the music, may create awkward effects and be inappropriate. Even the dynamics of specific instruments may have to be altered in certain venues; together with rearranging the position of the players, in order to produce the desired sound.

The amount and quality of reverberation that occurs in a natural environment is influenced by a set of factors: First, the volume and dimensions of the space; and the type, shape, and number of surfaces that the sound encounters. Acoustical energy travels at the speed of sound (approximately 345 m/s) in all directions from the source with only a small portion of this sound reaches the listener directly. The listener also receives many delayed reflections of the sound off the walls, ceiling, and floor of the

space. These reflections in turn elongate the perceived sound of the listener as the amplitude of any sound is reduced by an amount inversely proportional to the distance that it travels. Therefore, reflected sounds not only arrive later to the listener's ear, but also carry lower amplitudes than the direct sound. (Dodge & Jerse, 1997)

In some of his early, groundbreaking studies about room acoustics, W. C. Sabine (Sabine, 1972) found that reverberation time is contingent on the room-volume and the make up of its reflective surfaces. Large rooms therefore under normal circumstances have long reverberation times. As long as the sound is kept on a constant volume, an increase in either the reflective surface-area or its absorptivity generally decreases the reverberation time. Moreover, as all materials absorb acoustic energy to a certain extent, a sound wave reflected off a surface looses some of its energy. Surfaces like cement, which is hard, solid, and nonporous reflects sound very well, while soft ones like fabric, textiles, curtains and porous materials such as plaster absorb a considerable amount of the acoustic energy. Likewise, a surface roughness also affects the quality of the reverberation. A sound wave striking a surface that is not flat, parts of the sound is (Figure 5.) dispersed in many arbitrary directions. Generally, the rougher the surface is, the greater the proportion of energy is that is dispersed. Therefore, in a concert situation much like PT is offering, there are additional surfaces beyond the walls for sound dispersion, absorption, and reflection, such as for instance furniture, carpets, people, and clothing, all which will affect the character of the recordings, becoming a true fingerprint of the venue.

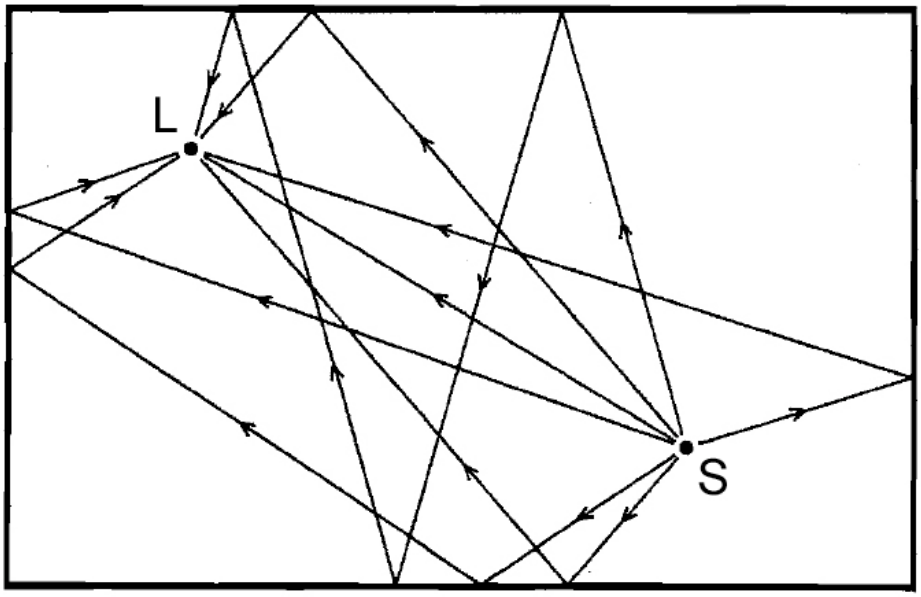

Figure 5. A few of the myriad of paths of sound travel between a source (S) and listener (L)

A networked sound installation in Canada utilizing the unique acoustic properties and reverberation of a very unique venue, and allows users remote access to it over the Internet, has been baptized the “Silophone”.

3.2.2 The Silophone

Silophone is a networked art project initiated by Montréal based arts collective “The User”, and an artistic collaboration between architect Thomas McIntosh and composer Emmanuel Madan. The installation consists of an abandoned grain storage facility, Silo #5 in the port of Montréal that has been empty since 1994. In the past, the silo was filled with grain, but is now instead filled with sound. The sound that fills this silo is channelled either via phone or the Internet into this empty concrete corpus, and bounce around where a microphone picks up the echoes and returns them to the listener. The silo’s chambers reach up to ten stories in height and have an impressive reverberation time of sometimes more than twenty seconds. In the silophone it is said that sounds are transformed into something completely different than the original. The

silo, built in 1958 is many times mentioned as a masterpiece of modern architecture situated in the Montréal harbor and has three separate sections joined together by elevated corridors. The reason for the initiation of this kind of project, according to Madan and McIntosh was to bring the public sphere into the silo to experience the unique acoustics of this space. However, as the Old Port of Montréal did not welcome the general public, the creators resorted instead to bringing the acoustics to the outside world. The Silophone project therefore takes great advantage of the very unique and exceptional acoustics and networks it, opens it up to users playing and listening to their personal recordings via telephone or uploaded on the Silophone webpage. Another third option of sound production and listening is to produce sound directly at a microphone in a sonic observatory next to the Silo. All sound from the silo, no matter what origin can be heard through the live RealAudio stream at the Silophone webpage[10] or the sonic observatory through loudspeakers.

Figure 6. The Silophone (Photo by Thomas McIntosh)

[10] http://www.silophone.net/

3.3 Networked robotics (telerobotics)

As the PT system eliminates the performer and provides for "robotic performance" by means of the Disklavier, a main allure for composers using the systems might be due to our constant fascination of musical automata. This fascination dates back as far as to antiquity, particularly during the middle ages and the Renaissance. Some reports trace the production of musical automata as far back as to the second-century B.C. (Buchner, 1978). Leonardo Da Vinci produced a mechanical small type of upright piano called a "Spinet" and drum-set as early as in the 16th century. Following, Italian Gianello Torriano produced a life-sized female lute player for the amusement of Emperor Charles V of Lombardy (Wood, 2002). Even Beethoven, Mozart, and Haydn, among others, composed for automatic instruments, which not long after could be seen as manufactured toys with commercial intent in the mid 19th century (Roads, 1985).

In the 20th century, Conlon Nancarrow devoted his life to composing for the player piano (also known as Pianola or Autopiano) (Gann, 1995), other famous composers such as Stravinsky or Bartók also wrote for this instrument, exploring the possibilities offered by the emancipation from human hands having to perform a composition (Rowe, 1993, p. 4). More contemporary individuals such as sound sculptor, composer and inventor of music instruments "Trimpin" has developed ways of playing, trombones, cymbals, pianos, etc., through MIDI[11]. Another more contemporary work in the same area is League of Electronic Musical Urban Robots (LEMUR) founded in 2000 by musician and engineer Eric Singer and is a group of

[11] http://www.otherminds.org/shtml/Trimpin.shtml

artists and technologists out of Brooklyn developing robotic musical instruments[12]. The philosophy of the group is to build robotic instruments that play themselves (Singer, Feddersen, Redmon, & Bowen, 2004).

Even corporations such as Toyota have more recently launched robots including a five-feet tall "virtuoso violinist" with arms and hands individually equipped with seventeen computerized dexterous joints. A demonstration of the robot, its design and mechanical music was made through performing Elgar's "Pomp and Circumstance". This leads many to question however what intent Toyota has in the field of robotic-music and if they are sincerely interested in building new tools and platforms for genuine artistic expression or is it merely a technological curiosity that ebbs out in developing toy-like entertainment. (Kapur, Eigenfeldt, Bahn, & Schloss, 2008) Toyotas violinist may therefore be contrary to work in most academic and artistic circles that are intent on building musical robotic systems as new channels of human expression, new instruments that expresses new ideas in music, to push the boundaries of what is possible for recorded sound and human operators.

Other areas where robots have been applied quite successfully is particularly in percussion, where we see a lot of robots being developed, maybe because the sophistication you need to handle other instruments makes the drum an exciting entryway into exploring robotics. A number of different robots that drum have been designed, both in academia in and artistic circles. At Harvard University researchers have laboured at creating a robotic drum roll with the right accuracy (Hajian, Sanchez, & Howe, 1997), Gil Weinberg of Massachusetts Institute of Technology

[12] http://www.lemurbots.org/

(MIT) developed “Haile” exploring human - robot interaction (Weinberg, Driscoll, & Mitchell, 2005).

3.3.1 Robotics of Sergi Jorda

Sergi Jorda from Barcelona has been part of developing performative technologies that include robotics, “Afasia” is one of the most notable and is an interactive multimedia version of Homer’s epic poem The Odyssey. Although Homer back in the day was probably only a poet performer, and relied solely on his voice for reciting a story, Afasia is a wordless version, with speech omitted. Afasia consists of a robotic quartet, some additional electronic music, video and animations, altogether controlled by a performer fitted with an exoskeleton. Afasia was created in 1998, and was the third interactive piece produced by visual and performance artist Marcel.lí Antúnez, in collaboration with the mechanical sculptor Roland Olbeter and Sergi Jordà in charge of the software design, interactivity and music. The installation consists of a stage occupied by a robotic musical quartet designed and built by Roland Olbeter and made up of an electric guitar, a one-string violin, a drum and a three-bagpipe. While these robots play music, interactive 2-D animations and DVD movies are projected onto a screen filling the back of the stage. An image (Figure 7.) shows the robotic quartet at the Museum of Contemporary Art of Barcelona[13]. The robots are MIDI controlled and each of the robots has its own virtual MIDI port and driver installed in the main computer. The drum, the guitar and the bagpipe robots use pneumatic mechanisms fed by a common air compressor. The air is governed by electro-valves, each of them connected through a separated relay. The violin, on the other hand, is

[13] MACBA, Museum of Contemporary Art of Barcelona: http://www.macba.es/

only controlled though “stepper” motors. The drum and the bagpipe robot are both acoustic, while the guitar and violin robots are electric instruments. Afasia’s robots look like instruments, not like human players and is therefore not designed to be anthropomorphic (Singer, Feddersen, Redmon, & Bowen, 2004).

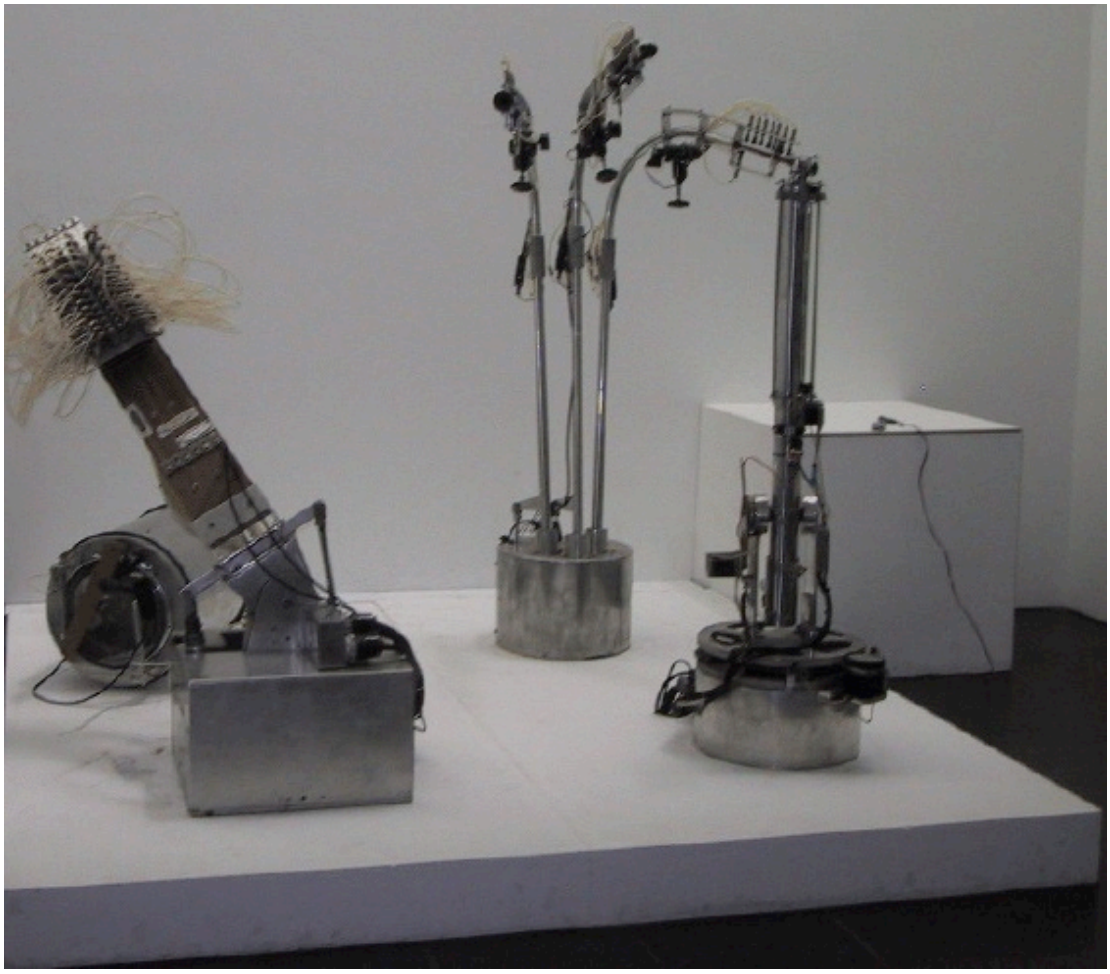

Figure 7. The Robot Quartet (MACBA, Barcelona 2003).

3.3.2 Ten Hand piano

The “Ten-hand piano” installation at Casa da Musica is a distributed musical structure with up to ten interactive performance terminals, designed in accordance with the buildings unique architecture by Rem Koolhaas, and are situated along the hallways, all together controlling one Yamaha Disklavier piano through a central server that

accepts incoming control data transmitted over the building's IP Network using Open Sound Control. (Barbosa A. , 2008) By interfacing on the stations by means of a mouse, and in one instance – a touch screen. Users control a box in wall-bouncing ball graphical interface where a keystroke on the piano of a certain pitch is generated when the ball hits one of the walls. The user defines the pitch by manipulating a control situated next to the wall. The server conveys the overall performance of each station and the sound is streamed back using an ETHERSOUND[14] system, producing latencies under 100 ms on the sites Local Area Network (LAN).

3.3.3 Robotics of Ajay Kapur

Ajay Kapur have been involved in developing some nice robotic work, mostly within percussion, and includes the MahaDeviBot (Kapur, Trimpin, Singer, & Suleman, 2007), a 12-armed solenoid based robotic drummer, Edholak and Etabla (Kapur, Davidson, Cook, Driessen, & Schloss, 2004) and Notomoton (Kapur, Hochenbaum, Darling, Diakopolous, Murphy, & Trimpin, 2011)

Moving from robotics on local networks to global, and when it comes to networked robotics governed by MIDI, Ajay Kapur have extended this research of musical robotics and various automata. Some examples can be found within "GIGAPOPR" (Kapur, Wang, Davidson, & Cook, 2005), a framework for low-latency, bi-directional networked media performance over a broadband connection. This system transmits MIDI data, multichannel uncompressed audio and video and was designed to enable geographically dispersed performers to interact with each

[14] http://www.ethersound.com/ (Cunsulted 2012/06/10)

other – and aims at recreating the experience of playing together as a group at the same place. In doing so both one-way and round-trip latency naturally affects the quality of the interaction.

The design of GIGAPOPR has only a few concerns and optimisations for low-latency, high-volume throughput. The whole framework is in turn subdivided into three applications, one for audio, MIDI and for video. These individual applications are made to run in a separate, independent process space. Giga_midi is the client/server application for capturing MIDI from any host and sending it with low latency to a remote host for playback. The “midi in”/sender host sends MIDI messages in a single packet to the receiver/”midi out” host, the MIDI data receiver can be mapped to external or onboard MIDI devices. Giga_midi was implemented through a custom module written with Advanced Linux Sound Architecture (ALSA), a free and open source software framework that consist of a set of kernel drivers, an Application Programming Interface (API) library and utility programs for supporting sound under Linux.

3.3.4 Various Yamaha Disklavier projects

One of the first attempts to remotely control an acoustic instrument over a network, a Disklavier piano, was the “Radio - Drum driven Disklavier,” (Jaffe & Schloss, 1994) linking a Drum to control a Yamaha Disklavier grand piano by means of a computer in 1998. Since then Yamaha launched the “Remote Lesson” software in 2007 to support real-time “at-a-distance” teaching for the study of the reproduction of particular performances by connecting two or more Disklaviers, preferable over Internet2, T1 and DSL connections, although the latter plagued by delay-times over a second. However, there are no systems to date that let composers join together in

collaborative concerts for a local audience by means of recorded MIDI such as in Perfect Take, although there are few systems that offer composers "telepresence" on MIDI instruments, mainly Disklaviers (Grand on Demand, 2012).

However, as these systems are more for interacting in real-time than for the rendering and recording of carefully elaborated compositions, they exclude artists who prefer *not* to perform or improvise live, but yet would like to employ network technology, the Internet and join others in concerts for exposing their work.

3.4 Interfacing

As PT is not a gestural controller, but rather a system that renders and realizes works produced on any musical controller of choice, a majority of users composing for perfect take will probably do so by means of a DAW and a MIDI piano where a performance will be rendered in a sequencer, to be edited, corrected, iterated and in other ways shaped to their liking. This interesting affordance, of shaping a musical piece by means of screen-based software's by means of finger or mouse-pointer is something Sergi Jordà notices in his PhD thesis.

"*In my opinion, several of the more radical and truly innovative approaches to real-time performance are currently to be found in the apparently more conservative area of screen-based and mouse-controlled software interfaces. Graphical interfaces may be historically freer and better suited for unveiling concurrent, complex and unrelated musical processes*" (2005, p. 157)

Although the musical data encoded in the MIDI-files to be submitted to our system can hardly be said to contain much "concurrent, complex and unrelated musical

processes", compared to that of much other computer generated music, screen-based software do open up for certain affordances difficult to imitate in any tangible musical interfaces or gestural controller. In fact, although many such new controllers are produced, few have made it into the mainstream and the list of new instrument virtuosi and/or professional musicians who use these, as their main instrument is surprisingly short. Some would even argue that no recent electronic instrument has equalled even the limited popularity of the Theremin or the Ondes Martenot, invented in 1920 and 1928, respectively (Battier, 2000) (Jordà, 2005). New emerging popular instruments do emerge, however many are neither digital, nor electronic. One of the more recent became a musical instrument in the early eighties, the turntable, when it was employed in unorthodox ways, far from originally intended. The turntable has since developed into a musical interface spawning its own musical culture and virtuosi (Poschardt, 1995).

In that sense, DAW's, sequencers, MIDI and mouse-pointers that promote the non-real-time, more reflective and iterative mode of making music have stood themselves well against the barrage of NIME's that evolve in an ever increasing speed.

"*Indeed, electronic music controllers evolve so rapidly that it's rare for a musician to work long enough with one to develop virtuosic technique* (Paradiso & O'Modhrain, Current Trends in Electronic Music Interfaces, 2003)"

The existing technique, skill and virtuosity that users already have of a MIDI piano, DAW and sequencer is harnessed in PT and be part of the quality and character of the concert. In that sense a system like PT is unlikely to become quickly outdated, as any

gestural controller to produce MIDI controller data is compatible with the system, while the sound-producing unit, the piano plus its space stays the same for decades.

"*It is my personal belief that the study of sound control, mapping, ergonomics, interface design, etc., lower-level and focused research in short, which tries to solve independent parts of the problem is clearly essential for any real progression in this field, but clearly it is also insufficient. Integral studies and approaches, which consider not only ergonomic but also psychological, philosophical and above all, musical issues, even if non-systematic by definition, are also needed*." (Jordà, 2005, p. 163)

In this sense, Perfect Take, as a new interface for musical expression, moves the concern of NIME as an area of research from that of sound control, mapping, ergonomics and interface design into investigating psychological, philosophical and musical issues of how we interface with cohorts and audience, and is exactly what experience design is addressing.

Chapter 4

How computers and Networks Support Creativity

As Networked Music and ICT's are providing the infrastructure supporting today's global musical culture and creativity, we will have a look at how computers and networks support this phenomenon, and also at some practical examples of how musicians are being creative in this environment today, to end up explaining how PT fits into this mix.

Circumstances that are fundamental to creativity in music have improved significantly thanks to digital technologies in recent years. In this chapter we will therefore talk about the three most fundamental of these, the first one is the material of music itself or the new timbres[15] brought forth by the computer. The second relates to new ways we assemble and manipulate these timbres into music by means of the computer. A third concept relate to new ways we both access and disseminate sound and finished music in time and space in our musical culture by the means of the computer.

4.1 The Sounds

Since the advent of the computer, we no longer need to resort to hitting, rubbing or plucking physical objects to generate sound. That is why many of the sounds used in music today sound far from i.e. traditional piano, guitar or drum sounds. The advent

[15] The character of a sounds

of the computer and digital synthesis offers a greater acoustic range in form of pitch, loudness, and timbre (the character of a musical sound), far beyond that of traditional instruments and thus provides the ideal sound-designing tool for works of music. Designing a sound is a craft in itself and can be done in the many software synthesizers that come with today's DAW's or programmed in environments like Pure Data[16] (PD). A certain "sound-color", or timbre from the vast sound-pallet is in turn stored in form of sound sample files or "patches" and may sound like a piano, a guitar, or even a crackling fire or jet engine, resembling no existing traditional instrument. Most computer music programs come with many of these sound samples and patches pre-packaged, which may be tweaked, stored and further distributed and are highly sought after by artists as much as a soda manufacturer desires the recipe for Coca-Cola, or painters would like to acquire a certain yellow in a van Gogh painting.

Now, from a standpoint of creativity, sounds themselves may be new and surprising to a listener and therefore introduce novelty-value in music. This makes them a cornerstone in musical creativity and the emergence of new, surprising *sounding* music. The ability to choose the most appropriate sound for various musical elements is a skill few possess and is where creativity of the designer/composer comes into play. Both the sound sample, the patch and synthesizer are devised specifically for easing the way for users to find new sounds to use, which has resulted in a virtual boom in new ways employing sound in music. Only a century ago music was generally made up of a handful of sounds of certain timbres, pitches and loudness of the classic orchestra, compared to today's ever-growing variety.

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[16] http://puredata.info/

This brings us to the first step of supporting the creative process of making music: providing users with a vast pallet of sound from which to choose, and more importantly, assisting users in creating appropriate sounds in an efficient and intuitive manner through various interfaces or example tools we find in Music Information Retrieval (Leman M. , 2008, p. 185) that may help in querying sounds, finding synonymous ones, much like a word processor suggests words to a literary artist.

As sounds are only part of the final music to be considered creative, we will have a look at how we with the help of HCI creatively assemble these into what we call music.

4.2 The music

"*Computers are generalist machines with which software tools are programmed. By itself, a computer is a tabula rasa, full of potential, but without specific inherent orientation. Software applications endow the computer with specific capabilities. It is with such a machine that we seek to create digital musical instruments with which we can establish a profound creative rapport*." (Tanaka, 2006)

As we all know, music is not merely a sound, but plural sounds organized over time. A tool specifically devised for the task of assembling sounds into music is called a musical controller. The most common such is the MIDI-piano keyboard that registers input data from a user to produce sounds in attendant computer. Beyond the MIDI piano, HCI provides a whole array of sensors by which we may manipulate sound (Orio, Schnell, & Wanderley, 2001) (Varplanck, Sapp, & Mathews, 2001). Measuring changes in motion, light, gravity, pressure, velocity, skin conductivity or muscle tension are just a few of the ways that a player's gestural input can be turned

into musical output. This “mapping” of a certain action in the environment to a certain sound opens many creative possibilities and a wider variety of ways of assembling and shaping sounds into music compared to what we are traditionally accustomed (Wanderley & Battier, 2000).

4.2.1 Mapping

Important things to think about when it comes to a sensor system that is mapped to musical gestures, is that it needs to be deterministic and reactive. This because artistic satisfaction lies in the sense a musician has of his own actions in the resulting music or *a sense of musical agency* - the identifiability a musician maintain in feeling the contribution his part is making to an ensemble (Tanaka A. , 2006, p. 281). Therefore, the responsiveness of an instrument must turn subtleties of articulation into expression by simple and directed mappings between sensor input and sound synthesis, and at the same time offering complex and rich interactions, this can be done in three ways, in so called one-to-one, one to many or many to one.

The most obvious type of mapping is that which simply associates each single output control parameter (e.g. pitch, amplitude, etc.) with an independent control dimension. This is called one-to-one mapping. Given that most digital sound or music generators (sound synthesizer) involve many more parameters than the average controller can produce is commonly referred to as a “few-to-many” mapping (Lee & Wessel, 1992). And it is generally considered that reducing how many dimensions of control an instrument has makes it less frightening to its performer by “*by avoiding the redundancy inherent in the exponential growth of increasing dimensionality*” (Goudeseune, 2002).

One-to-many mapping on the other side can be better understood with a comparison to playing the violin and asking what the bow of the violin control? The bow obviously controls many aspects of the generated sound, including volume, timbre and pitch. As a contrast, a many-to-one (Rovan, Wanderley, Dubnov, & Depalle, 1997) mapping can be best depicted by the "volume control" of a violin. As we all very well know, there is no single "volume control" on a violin. Instead the bow speed, bow pressure, the choice of string and even finger position (Hunt & Kirk, 2000) will determine the volume of sound.

Real instruments however exhibit complex control behaviours that involve both these type of mappings, one-to-many and many-to one intertwined in intricate relationships, rather than exhibiting a more music-like behaviour than simpler one-to-one relations. Mapping can therefore be said to define the personality of an instrument. A mapping may make an instrument more playable or less so. Whatever choice of mappings a instrument designer chooses, this will result in what performers sometimes call the "feel" of an instrument, its responsiveness and controllability, its consistency, continuity and coherence (Garnett & Goudeseune, 1999). Mappings also determine the way an instrument is learned and approached by beginners and any change or update of software, controllers or their particular instruments often means learning the new mapping.

"*Interposing a computer in the loop between physical action and musical response allows essentially any imaginable sonic response to a given set of actions; this is termed "mapping". As digital musical interfaces are so recent, there is no clear set of rules that govern appropriate mappings, although (arguably) some sense of causality*

should be maintained in order that performers perceive a level of deterministic feedback to their gesture" (Paradiso, 1997)

The second step in supporting the creative process of music is therefore in providing novel and exciting way of setting, shaping and connecting sound over time – or making music basically. Examples of these can be found in NIME research, a special interest group that over the years have provided a whole array of interfaces and mappings to help individuals or groups, as in Reactable systems (Jordà, Kaltenbrunner, Geiger, & Bencina, 2005) express themselves musically, over networks and/or locally. (Figure 8.)

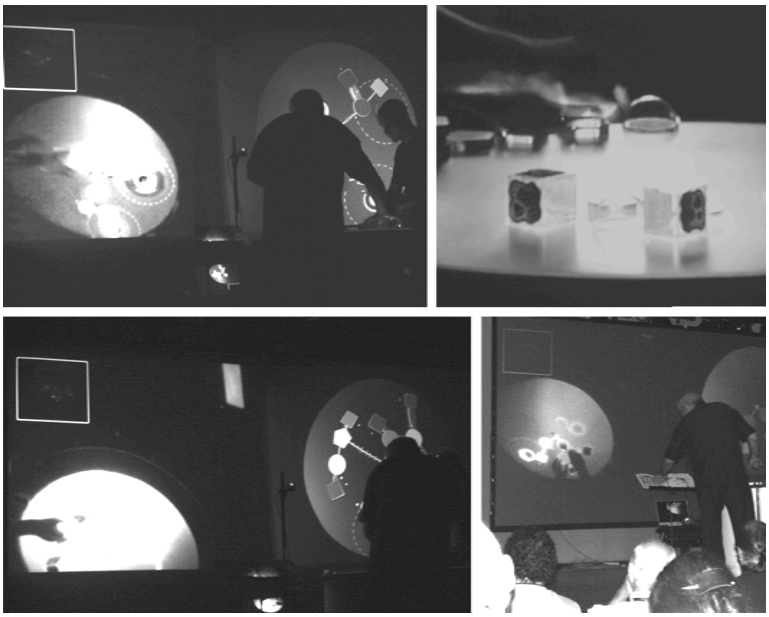

Figure 8. "TeleSon" Performance September 04, 2005: Chris Brown and Gunter Geiger at ICMC 2005 in Barcelona, Spain (on stage ate SGAE auditorium); Martin Kaltenbrunner and Marcos Alonso at Ars Electronica Festival in Linz, Austria (on screen).

4.3 Musical Culture

"*Computer music by its nature could until recently only be individual, solitary music. However, with the introduction of microprocessors at a reasonable cost, composers can now own microcomputers, and true computer bands, free from major institutions, are possible. Though such bands can take many forms, network music seems more suitable and contemporary*" (Bischoff, Gold, & Horton, 1978).

So far, we see how new sounds assembled in new ways by means of computers supports musical creativity, but we have spoken little about how musical culture, or the actual sharing and shaping of musical styles, sounds, ideas and forms (Toynbee, 2000) (in the form of patches, sounds, music) is supported technologically. After all, this is the very infrastructure that facilitates creativity in music today. One of the best-illustrated examples of this creative space is the four-quadrant conceptualization of CSCW for music applications mentioned earlier - provided by (Barbosa Á. , 2008) depicting various Networked Music systems. This depiction not only shows various ways of making music over computer networks but also the exchange of musical styles, sounds, ideas and forms over time and space. It shows various interactive scenarios and how we by means of networked computers share timbres in form of live or recorded sound, sound-samples and patches, and music with lightening speed across the world and even over time, from times present and past. This has of course has had a tremendous impact on our musical arts and creativity that relies on transforming information in all shapes and forms, received in interaction with other musicians.

This networked landscape is not only the infrastructure to facilitate an exchange of musical ideas, it is also the very test bed for these ideas, and their

potency as finished works of art among the three tiered axis The *individual*, the *field* and the *domain* that according to some creativity researchers brings forth those cultural productions we label as creative in society.

4.3.1 Creativity in Musical Culture

Traditionally, research into creativity defined it as a linear, problem-solving process (Dewey, 1910) (Rossman, 1931) (Wallas, 1936) or a specific form of intelligence which certain persons was endowed with (Guilford, 1959). These approaches naturally perpetuated the "lone genius" definition of creativity, exaggerating the role of the individual and their output at the expense of the process and place influenced their creation. Even though early research acknowledged that being creative partially involved making new and unique associations, it disregarded how it was actually accomplished, and as a consequence activities such as appropriation and re-contextualising someone else's ideas and creations was never paid much attention to. Csikszentmihàlyi and Getzels (1988) were some of the first researchers to discuss individual and person-product notions of creativity and to address how previous models failed to account for one of the more fascinating characteristics of the creative process, that of a persons capacity to define the problem nature and the processes this involved, and in by so doing highlighting the social context of creativity. In later research, Csikszentmihàlyi discusses how creativity emerges by means of a dialectical process of *individuals* of talent, *domains* of knowledge and practice and *fields* of knowledgeable judges (Csikszentmihalyi, 1999). This dialectical process, he argues that over time, bring about what and whom we consider creative.

A creative individual is someone who transforms the fields in which they act. There are several conditions that favour innovative action, such as personal characteristics, the dedication to experimentation or a privileged position in the domain.

The Domain is the accumulated knowledge in a certain area and is operated by means of a set of objects and tools, representation rules and notations.

The Field comprises of specialists, professionals or those who judge and critique new work in a domain and influence the way in which the works are accepted or rejected in the social sphere. Their actions therefore build a consensus surrounding new work, inter-subjectively at any given point in time.

During the 1980s similarly, Amabile (Amabile, 1989) initiated research to systematically study how "qualities of environments", or the factors beyond the individual have an effect on creativity. What Amabile found was that extrinsic factors such as reward, evaluation, competition, surveillance and restricted choice, prevented or promoted creativity. Musical creativity therefore can be said to be as much favoured by psychological factors as it is affected by cultural and social, emerging as a process that can be observed only, according to Csikszentmihalyi, at the intersection where *musicians*, *musical domains* (or *idioms)* and *fields* knowledgeable in music, interact.

Even though research recognized the influencing factor of context, or socio-cultural environment on how we define creativity, individual based conceptual models still dominated much research until the 1990s (Boden M. , 1990). As a consequence it is not until the past decade that there has been an increasingly greater understanding

the collective creative processes in most fields including music (Dillon, 2003) (John-Steiner, 2000) (Miell & Littleton, 2004) (Sonnenburg, 2004) (Sawyer, 2006). At the core of all this work lies an effort to understand the complexities of reciprocal and interdependent process between the individual and the social, which contribute to creative expression. On the basis of this, it is through an understanding of the creative collective processes that we can begin to appreciate the role of appropriation and re-contextualization of music by means of digital technologies.

The third step in supporting the creative process of music is therefore in facilitating and improving the infrastructure of this spatial-temporal musical discourse among *musicians, domains* and *fields*. This includes improving the effectiveness, functionality of musical communication over time and space, not only preventing latency and quality losses when musical data is transmitted over the web in real-time situations, but also improve upon ways sounds and music are shared, queried and retrieved *among a population of musicians*, in a *culture* to benefit the current musical situation such as seen in freesound.org and ccMixter. An example of this is what Jorn Lemon developed while at Music Technology Group in Barcelona in 2005, and relates to content base processing and analysis of musical signals. Mootcher is a PD external, which allows the access to freesound.org, the vast, user driven database with sounds from all over the world. This application allows for remote access to an up-to-date global sample database in a single PD patch and allows for new and interesting ways to access these samples, including keyboard-browsing and a synonymous, "similar sound", text approach to browsing. A user may also upload to and download sounds from the database, and in this way, and under the CC license exchange sounds with other music-makers and sound artists.

Supporting the creative process of music culturally also includes how a *field*

and *domain* handles new musical ideas in form of pieces of music and sound art, judging, debating, and transacting their merit. This includes providing ranking and recommendation systems, such as Twitter, various blogs and other forms of social media etc., where influence and opinion can be shared, to make break creative musical products. These technologies all taken together help improving a networked ecology of musical creativity, and supports the genealogy of what emerges as "creative" in our musical culture.

Now that we identified the main necessary circumstances that support musical creativity and how creativity in sounds, music and culture are augmented by HCI, let us have a look at some concrete practices of how composers are creative in this environment.

4.3.2 Designing Creative Music

As we have seen, musical creativity is generally considered to be about the production and realization of *new* and *valuable* output (Leman M. , 1999), to use design terminology, a "wicked problem"[17] most musicians are facing indeed. The reason for this can seen from the perspective of composer Aaron Copland where making music as a search of self-discovery.

"*I must create in order to know myself, and since self-knowledge is a never ending search, each new work is only a part-answer to the question 'Who am I?' and brings with it a need to go on to other and different part-answers*." (Storr, 1985, p. 276)

[17] Problems (traditionally social) which constantly change and are therefore difficult to solve, or may have changed once you've found a solution for it. Skyttner, L. (2005). *General Systems Theory: Problems, Perspective, Practice.* Singapore: World Scientific Publishing.

Similar to the wicked problem in design, the musical "problem" address needs that can never be solved as true or false, but rather approached as more or less appropriate. To make it even more complex, music may even arouse emotions and moods that have never before been felt and reveal passions previously unknown to both composer and audience (Storr, 1985, p. 118) (Langer, 1957). In the words of Oscar Wilde:

"*After playing Chopin, I feel as if I had been weeping over sins that I had never committed, and mourning over tragedies that were not my own. Music always seems to me to produce that effect. It creates for one a past of which one has been ignorant, and fills one with a sense of sorrows that have been hidden from one's tears*." (Jourdain, 1997, p. 322)

Composers traditionally bravely faced the "problem" of self-discovery by pushing the boundaries of established musical norms and idioms, carefully adding valuable musical "points of views" for themselves and subsequently their audience.

4.3.3 Breaking stylistic idioms

In this severely "ill-defined" problem definition (Leman M. , 1999, p. 286), a musician is considered creative when not only incorporating what has been done before but introduces a point of view that is unexpected and that adds new possibilities for further exploration. Introducing new valuable points of view in music (or being creative) therefore traditionally includes breaking stylistic idioms. During the 19th century the idiom was the Romantic which contained musical genres and forms such as the sonata, the concerto, and symphony etc., which provided schemata

by which composers constrained their creative thoughts or added new extensions or ideas. Idioms therefore work as the backdrop against which novelty is measured in the form of technical and stylistic progress and work to guide creative thinking concerning what timbres, sounds and music seem progressive and thus exciting to a composer. Creativity in music therefore, similar to other human endeavours emerge out of recombinant activities such as Bisociation (Koestler, 1964) or Conceptual Blending (Fauconnier & Turner, 2002), referred to in music as "Associative theories" (Hargreaves, 1986, p. 155) and point towards a inherently social *modus operandi* of musical creativity, be it in explicit and reciprocal as we find in a collaborative Jazz improvisation, or the less so in a solitary composer. Therefore, employing timbres traditionally found in i.e. Jazz, in Techno, or musical syntax traditionally found in Tango in i.e. Ambient music is what brings both novelty and value to music. Thus it is imperative that the access of patches, sounds and samples offer ample possibility for breaking musical idioms and provide ample opportunity for cross-pollination by supporting the conditions for "bisociative" creativity, and is again a way support music culture and thus creativity.

This last point relates interestingly enough to the "expressiveness" of musical instruments in general, its ability to play different styles of music where, the computer music instrument taken in its totality with its various softwares is undisputed champion compared to traditional instruments.

"*One can also talk about expressiveness of an instrument to suggest its ability to be used to play different style of music* [...] *Musicians are not supposed to be constrained to a musical style and are supposed to be able to switch from one to another, crossing the frontier between them*" (Arfib, Couturier, & Kessous, 2005).

How to best provide the breaking of idioms and adapting to many styles technologically and interactively will have to be an exciting prospect for future research. A technique however that composers specifically use is by a re-combinatory or bisociative act called "sampling", where musicians are seen engaged in cross-pollination of concepts by literal quotation of past or present musical material.

4.3.4 Musical "design patterns"

With the advent of sampling culture, recorded part of musical works become the perfect tool for mixing and matching various musical material in a quest for the new and valuable combinations across musical idioms. The reason for this is that samples works as prefabricated solutions to musical "problems" such as the right timbre, melody or beat for a certain circumstance. That is why samples re-occur in many songs - as they constitute tried and tested, oft-used solutions to various musical situations. This in turn likens them to "design patterns", or tried and tested architectural elements, as we know them from Alexander[18] (1979). Even here, most software packages come with this musical "pattern language" ready to be deployed. This has made what's referred to as sampling culture, a mode of making music quite significant of postmodernism and our time. This, many argue, has changed the very essence of creative practice in contemporary music from assembling individual notes to assembling larger pre-fabricated musical structures, moving skill from that of instrumental operation, to that of judgment. Hence,

[18] A structured method of describing good design practices within a field of expertise.

"*An artist is now much more seen as a connector of things, a person who scans the enormous field of possible places for artistic attention, and says, What I am going to do is draw your attention to this sequence of things.* " (Eno, 2004)

Therefore, it comes with little surprise that re-combinant music practices have become popular with the advent of computers and worldwide Ethernet networks, launching sample based musics like Hip-Hop and electronica as the de-facto modes of music making of the 21:st century, tapping consumer memories of parts of old songs and sounds and redeploying them in the present (Lipsitz, 2005, p. 512).

A great example where this "musical pattern thinking" guides the design of interactive music systems is in the WorldBeat[19] music exhibit, which treats users as designers that in the process get basic principles of making music communicated through a pattern approach. This in turn is argued to provide and easy, didactic way of interacting with various musical ideas (Borchers, 1999) as such a system encourages exploration of bisociative creativity, mainly among novices by shifting focus from details of instrumental skill to that of judgment of large-scale "design" issues in music.

Diving deeper into sampling activities we find that it relates more to human tool-making, and specifically the phenomenon of *appropriation* than previously than first meets the eye.

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[19] Borchers, J. (1999). Designing Interactive Music Systems: A Pattern Approach. *Human-Computer Interaction: Ergonomics and User Interfaces. Proceedings of the HCI International '99 8th International Conference on Human-Computer Interaction, Vol. 1.*, (pp. 276-280).

4.3.5 Appropriation in sampling/mash-up/remix culture

Socio-cultural theorists have attempted to go beyond the analysis of cognition as a phenomenon of the individual, instead emphasising the importance of social interactions and participation in cultural activities for its development, just as we see with creativity research (Rogoff, 1995) (Vygotsky, 1978) (Wertsch, 1985). By doing so, emphasis is placed on the relationship between the individual and their environment and how these are mutually constituted, looking at the intertwining of various natural and biological process and how these are affected by psychological and physical tools such as speech, pens, computers and various media. Central to this viewpoint is the idea that all human activity is *mediated* in the sense that humans make and use tools and signs to communicate with the world around them. The same theorists continually highlight the ways in which cultural tools and activities are part of a socio-cultural context and derived from situated social practices that have progressed through history.

Appropriation, defined socio-culturally (Engeström, 1987) (Rogoff, 1995) is central in understanding how we employ cultural tools, in this thesis, the term will assist in understanding how we reuse and re-contextualize existing music in order to create new ways of making music.

Throughout the ages, humans have learnt to appropriate, or make and use different tools like fire, stone, steel, pens, computers, making them suit their purpose, making them "our own". This process is what socio-cultural theorists refer to as "appropriation". In music, classical composers use and reuse scores and notational forms to produce new music. In the same way, many electronic artists sample and resample already existing music, "other" people's music, to spawn new creations. However simple it might seem, creative appropriation in music is a process of a

certain complexity. It involves understanding how piece of music is designed and currently employed by others in ones culture, and also how it is perceived in culture. As an example, in order for an artist to crate a new track by means of pre-recorded samples from other artists, to do it successfully, he/she needs to be aware of a wide range of music in their chosen genre to extract the samples they require. They also need to know how to shape and transfigure the sample to change its character, which includes the tact and musical expertise to know what works and does not. It includes the ability to employ the transfigured sample in a musically interesting way in their creation. Unfortunately this process also involves having an understanding of, and circumventing copyright laws.

In this sense, appropriation in music is not just about particular individuals thinking processes but about the mutuality between the individual and their environment in the sense that it recognises how by actively engaging in an activity, one can also transform it. In this way, Rogoff (1995) considers how the person who is participating in an activity is a part of that activity, not separate from it. Therefore, appropriation is not a one-way street, but essentially involves an understanding of the relationship between a society's current understanding of an activity and tool, and an individual's take on it. According to Engeström (1987) this relationship may create tension, especially when the creative individual's interpretation differ from that of his/hers society as can be seen in Dadaist and surrealist movements, such as Marcel Duchamp's *fountain* (a urinal) and his *L.H.O.O.Q.* (moustached Mona Lisa).

Appropriation in music today can therefore be defined as a global activity consisting of the creative and efficient exchange of information facilitated by digital technologies such as the personal computer, networks and various software applications. As a phenomenon, it is supported by the practice of cut/copy and paste,

which is interestingly enough one of the central features of software packages in a variety of fields, including music running on personal computers. Some early forms of appropriation, seen as a natural facet of musical derives from the music "remixes" produced in New York City in the late 1960's and early '70s with ancestry in the music of Jamaica[20]. Since then appropriation in music (the activity of using samples from pre-existing music combining them into novel forms according to taste) during the first decade of the twenty-first century, has been ubiquitous in art, music and culture at large; it plays a central role in mass media, especially new digital media. To understand musical appropriation as a cultural activity, we must first define what it constitutes in music and can be seen as a reinterpretation of pre-existing music, many times with the certain quality of the original still present or dominant in the new artwork.

Some of the more obvious, and very common form of appropriation is that of "remixing". Remixes most often come in three types, the first one is by *extending* a existing artwork, a longer version of the original composition containing long instrumental sections to make it more mixable for the club DJ. The first known disco song to be extended to ten minutes is "Ten Percent" by Double Exposure, remixed by Walter Gibbons in 1976 (Brewster & Broughton, 2000, p. 178). The second remix is what could be called *selective*. This remix consists of adding or subtracting material from the original composition. This type of remix made DJs popular producers in the music mainstream during the 1980's. The third remix is *reflexive*, and extends the aesthetic of sampling, where the remixed version "challenges" the original and claims

[20] For some good accounts of DJ Culture see Bill Brewster and Frank Broughton, Last Night a DJ Saved my Life (New York: Grover Press, 2000)

autonomy even when carrying the same name of the original by material being added or deleted. (Navas, 2010)

A term that lately has come to encompass many of these appropriative activities is *participatory culture* and which recently become the central mode of information generation on the web.

4.3.6 Participatory culture

As PT can be seen as a participatory-driven concert system without gatekeepers or curators, it can be interesting to look at participatory culture, a cultural phenomenon that has sprung up quite recently as one of the more powerful means by which we today construct knowledge, and very much in the forefront of the so called Web 2.0 era where consumers of information are not seen as mere passive recipients, but also active producers of content and meaning.

Digital culture in general is constantly driven forward by new, improving and changing technologies. This has changed, as we all can obviously see, the media landscape the past twenty years. Soft and hardware and the advent of the Internet and the popularization of the World Wide Web has provided us with a communication technology that has considerably altered the size and scope of our media landscape in how we access, interact with visual and aural information. Together with this change "mass media" as we used to know it has lost its privilege of a monopolist, status of one-way control structure – and instead participatory culture and media is breaking through the prevalent controlled mass media information channel. At least this is what we see among those who promise for democratisation and a more active engagement of the user, who, empowered by user-friendly and affordable technology, today actively take part in the making and shaping of information that influence public

opinion. The consumer is now the "prosumer", that aims at transforming the couch potatoes into self-directed producers engaged in a medium that is now bilateral, and to be interacted with. Ideas surrounding the artificial separation a producer from consumer are nothing new and emerged alongside the advent of our earliest mass communication devices. As early as in 1932 Bertolt Brecht noted:

"*...the radio could inarguably be the best apparatus of communication in public life, an enormous system of channels – provided to function not only as a sender but also as a receiver. This means making the listeners not only listen but also speak; not to isolate them but to place them in relation to others.*" (Brecht, 1967)

Art as a collective form could according to Brecht's revolutionise the existing social system by collectivising those who send and those who receive. In that sense, every loudspeaker is a potential microphone – and as Enzensberger put it, every receiver could be a potential sender. (1970) As a outcome of this critique of mass media, which indicated the artificial separation between producers and consumers, American pioneer of sound art, Max Neuhaus, combined a radio station with the telephone network to create a two-way public aural space encompassing New York City and twenty miles in diameter, where any inhabitant could join a live dialogue through sound by making a phone call, in his first "Public Supply" project in 1966. Neuhaus's project was remarkable in the way that his approach did not purely focus on the intrinsic possibilities of new media but rather on

"*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." (Neuhaus, 2012)

Other technological developments that related to user-driven content and user engagement was that of pioneer Ted Nelson who published a paper in 1965 named "*A File Structure for the Complex, the Changing, and the Indeterminate*", where he was the first to coin the term "hypertext", i.e.

"*a body of written or pictorial material interconnected in such a complex way that it could not conveniently be presented or represented on paper*." [21]

In his work Nelson introduced a new notion of "file operations" that allowed text, films, sound and video recordings to be arranged as non-linear systems. What today seems to be routine on the Internet and PC's was over forty years ago a revolutionary way of thinking about media that culminated in the seminal book Computer Lib/Dream Machines (Nelson, 1987) where he essentially argued that computer experiences in general are such that they benefit from being co-designed with the audience in mind as a creative process (Sonvilla-Weiss, 2010). By doing so he proposed to place the design processes in an open publishing network that ought to support reconfiguration, comparison and interconnection, much like in what we today see in Wikipedia, and his currently ongoing project Xanadu[22]. In the light of these

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[21] Nelson, T. (1965), A File Structure for the Complex, the Changing, and the Indeterminate. In: Wardrip-Fruin, N. and Montfort, N. (2003), The New Media Reader, p. 144. Cambridge, Massachusetts: The MIT Press.

[22] http://www.xanadu.com

seminal ideas of new ways for the general public to experiences in form of composed media PT stands as a remote, user-driven, participatory and inclusive in essence.

Many of these activities naturally involve conflicts concerning copyright etc. wherefore a legal model for cultural contents rights management was devised to addresses the inadequacy of copyright laws in this new exciting ecology.

4.3.7 Creative commons

The Creative Commons[23], or CC as we have already spoken of is a licence is a non profit organisation that provides a legal model for cultural contents rights management that condones copying for purposes of re-use pioneered among others by the renowned lawyer and cyber theorist Professor Lawrence Lessig. This model is intended to complement our existing copyright law and addresses the inadequacy of copyright laws to deal with the models of dissemination possible on computer networks. Creators have the means to have their work available to others by providing flexible opt-in licensing systems, thus providing musicians with greater control over how their music is released and used. This licensing model allows therefore copyright holders to grant permission for secondary use of their creations including copying, modification and re-distribution under certain conditions without abandoning their unique authorship rights and by doing so it successfully recognises the link between how music is distributed and how it is made.

Music is one of the main areas where CC has tried to establish itself, and where appropriative and participatory musical cultures like that of sampling and re-mixing, play a central role and therefore works as models of inspiration for

[23] http://creativecommons.org

distribution frameworks like CC. While the CC identifies remixing etc. as creative acts, it merely provides a legal framework for artists to distribute their works, and naturally does so without providing the means, tools or techniques for artists' various repurposing activities.

4.3.8 How PT facilitates creativity

With PT, the only sound and timbre offered to composers is that of the piano, we therefore don't offer new and exciting sounds for the productions of new musical works, neither do we provide a new way for users to assemble sounds into music per se[24], however as the remote concert, venue, audience and technologies is all part of the recordings that will constitute the "artwork" to be created, we do provide a new environment, a new interface for such a realisation by a collective. Where Perfect Take however works as a tool to support creativity lies in it facilitating recorded piano works for download by cohort composers and the general public under a CC license, where composers provide their works up for re-use, or *appropriation*. Therefore, PT only attempts to improve one of the three (sound, music, *culture*) conditions that are suggested in this research, which is probably enough as an initial investigation into these issues.

Now that we have covered the history of networked music and some theory and practices involved in creativity in this area we will look at what it is that makes people want to collectively create in music. One such theory, that we have chosen for the design of PT, tries to explain why we use any technology is that of *experience*

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[24] Most users of the system will most likely resort to using the MIDI-piano, keyboard and mouse by manipulating MIDI data in the sequencer, although any controller can be used to generate the MIDI.

design, a field of research in design that tries to capture the psychological drivers and motives behind users behaviour. These, it is argued, are important to take these into consideration to design apt, useful and rewarding technologies.

Chapter 5

Experience Design

5.1 Experience design in design

Design and development is a multi-disciplinary effort that must take into consideration the input from the multiple disciplines involved. This often involves an iterative approach where designs are evaluated by usability practitioners alone or with end-users and result in the identification of usability shortcomings. These evaluations focus on identifying usability problems that require resolution before a design is released for widespread use by its intended user population.

However, experiences we have with technologies are shaped by more than usability, the temporal engagement that many new technologies provide demands a more holistic point of view in the analysis and design of human-computer and human-human interaction. Interacting with a technology over time constitutes an *experience*, and designing for experience differ from designing for interaction in many significant ways. The first is that such an approach should take into account the ease and pleasure of using a technology over time, plus taking rather intangible sensorial, cognitive, and emotional aspects of interaction into consideration (Mulder & Terrenghi, 2010). In traditional usability studies, time dimensions have been compartmentalized into single tasks that are acknowledged, analysed and dealt with. Experience design however embraces a broader perspective and focuses on the quality of all interactions taken together, as almost in a "gestalt", rather than individual segments. In this way the whole relationship between a user and a product is designed for whole period of engagement (Forlizzi & Ford, 2000).

Norman, in his seminal book "Emotional Design" (2004), describes studies that suggest there are three levels of processing information important to design of products/systems, first the *visceral* level dealing with instinct, then the *behavioural* level dealing with behaviour and use, and last the *reflective* level dealing with contemplation. In this line of thought, *experience designing* would be active in designing the first impressions, through its usage, cultural role, and to the contemplation of the whole relationship with the technology. Usability and user centred design together with experience design therefore provides a more holistic understanding of users that addresses ergonomic as well as social and psychological dimensions and brings many new interesting facets of design to mind.

"*Being inspired by user's fundamental psychological needs is an interesting approach in the experience design process, particularly for developing innovative new concepts*" (Kim, Park, Hassenzahl, & Eckholdt, 2011)

This dichotomy, of usability and function on one hand and the less tangible *experience* on the other is what Hassenzahl, Platz, et al. (2000) labels Ergonomic Quality versus Hedonic Quality of products. Ergonomic quality (EQ) refers to the usability of the product, which addresses the underlying human need for security and control. The more EQ a product has, the easier it is to reach task-related goals with effectiveness and efficiency. EQ focuses on goal-related functions or design issues. Hedonic quality (HQ) on the other hand refers to quality dimensions with no obvious relation to task-related goals. These include various human needs (originality, innovativeness, novelty or change and striving for social power are mentioned) that user feel they will satisfy by a visual design, sound design, novel interaction

techniques, or novel functionality etc. They argue that a product can possess more or less of these two quality aspects.

A further exploration into the hedonic quality of products, and various human needs is what has been labelled a "psychological needs-driven experience design approach". (Kim, Park, Hassenzahl, & Eckholdt, 2011) where needs, similar to, and also based on Sheldons (Sheldon, Elliot, & Kim, 2001) research were selected. IN their research they list: Autonomy, competence, relatedness, stimulation, influence and security. In more detail:

Autonomy is when we feel that we are the cause of our own actions rather than subjugated to external forces that dictate our actions. *Competence* is feeling capable and effective in our actions rather than feeling incompetent or ineffective.

Relatedness is feeling in intimate contact with people who care about oneself and that one cares for rather than feeling lonely and uncared for.

Stimulation is feeling enjoyment and pleasure rather than bored and under-stimulated in life.

Popularity is feeling liked, respected, and influential rather than feeling neglected.

Security is feeling safe and in control of ones life rather than feeling uncertain and threatened by her circumstance.

It is important to note that these set of needs are shortlisted not as a definite classification, but are rather aimed at covering some interesting experiences to elaborate on and evaluate in a design. In very much the same manner, we defined some needs, specifically of a socio-emotional nature that we employed when designing, and use to evaluate the experience of PT, (as we'll see in chapter 6). First however, let's have a look at thoughts around experience in the design of new musical instruments and systems.

5.2 Experience design in NIME

In the context of designing new musical interfaces and systems, designing for experience is mentioned by Atau Tanaka in shared experiences relating to his systems that attempts to situate the individual musically in collective action (Tanaka A. , 2006, p. 278).

"*An understanding of experience from* [a musical] *perspective could lend a richer more profound understanding than a design or economically motivated exploitation of the term*." (Tanaka A. , 2006, p. 282)

Atau Tanaka describes this deeper understanding of what makes musical technologies rewarding to use as the "total musical *experience",* an experience that is to be designed for and consists of the sum of *instrumental idiomaticity*, *user-instrument interaction* and a *users sense of agency.*

Idiomaticity of an instrument refers to what an instrument is capable of expressing through the acoustical and mechanical constitution of the instrument. Although two

instruments may play the similar melodies in a tessitura[25] they still produce music of a particular character. This is not only through different modes of articulating sound, but also differences in polyphony and atypical melodic intervals associated with the instruments.

User-instrument interaction relates to the various dynamic relations that exist between a user and his instrument, much like Donald Normans *decision cycle model* (1986) that depicts in seven steps how a user interacts with a system: Goal formation, translation to intention, translation to commands, execution, perception of state, interpretation, evaluation against original expectations, reformulation of goals, restart loop. In music however, this interaction is not only dependent on the relationship between the musician and his instrument, but also if a group on stage, a live, human interaction between musicians and also interaction between the performer and the audience.

Agency refers to the sense of having ones own actions represented in the resulting music, and the satisfaction thereof. It is also the satisfaction of identifying a contribution ones part is making in a group. He calls these particular notions a *sense of musical agency*. (Tanaka A. , 2006, p. 279)

5.2.1 New goals

Experience designing a musical interface therefore requires new goals to design and test for, goals addressing these more intangible needs, as traditional usability goals

[25] The range within which most notes of a vocal part fall.

i.e., effectiveness, efficiency, safety, utility, learnability, and memorability, (Preece, Rogers, & Sharp, 2002) fall short in covering the complexity of experiences we label fun, entertaining, motivating, engaging, and rewarding etc. Such goals naturally warrants a more open, rather than utilitarian design approach (Mulder & Terrenghi, 2010).

Some designers have tackled this by looking at performing arts such as scriptwriting, storytelling etc., seeking ways in how to craft rewarding experiences. (Laurel, 1993) (Sherdoff, 2004) Although we will not employ this method explicitly in our research, it is worth to mention that storytelling is a useful method to not only recall memories (episodic memories) and experiences but also communicating stories and messages through the creation of interesting and positive experiences. In such a scenario, designers can be compared to play-writers or directors who set the plot and context, leaving the rest up to actors on the stage. All in all, experience designers can therefore be said to design an environment within which users complete an experience for themselves.

5.2.2 The value proposition

A value proposition attempts to make sure the goals of potential users are embodied in a product or service and is supposed to address the raison d'être from the perspective of using it. The value proposition thus becomes the reason and incentive for users to use a technology, a call to action communicating the “added value” of using a technology (Mulder & Terrenghi, 2010) (Wilson, 2010). We traditionally equate “value” as the benefits, minus cost (Value = Benefit - Cost) where the cost of using a technology is not only financial but also practical, such as time and effort put into learning, using and maintaining it. If the cost is high, the benefit better be high, or

else no one will use it. Value propositions have traditionally been part of marketing and business although has recently, along with experience design, been employed as a tool for looking at innovation in design and technology. Thus, the value proposition of PT has been a central and natural part of the design process, and has, according to the author unexplored potential as a way of thinking concerning NIME's or the experience of a process, service, event or environment in which these operate.

As "benefit" can be seen as the met satisfaction of various needs and goals of users of PT, this required that we knew what needs we were designing for (like we saw in the previous example in the experience design for products). In our system supporting collective music activity, we derived these needs from pianists and piano duets, based on what makes them a fun and rewarding experience. These needs, some of which were socio-emotional, were in turn used in designing and evaluating the system.

5.3 The piano duet

The piano duet is a scenario where two performers play either on one or two separate pianos and is probably one of the most popular forms of musical collaboration with the same type of instrument found in western classical music. Investigating collaboration with the same instrument is valuable as compared to a string quartet for instance, where you often find obtrusive allegiances and conflict (Murningham & Conlon, 1991), also hampers the a study of creative collaboration. It can therefore be said that the existence of a duet is evidence that the collaboration is working. (Blank & Davidson, 2007) The two collaborative scenario's we have looked into, of one or of two separate pianos, differ in some detail regarding the skill that it demands such as vacating a key in time and avoid excessively moving your arms when pianists play on

the same piano, however the more intangible, psychological needs and goals of collaborating we are looking at are unlikely to differ to any significant degree.

As a piano duet is a fairly unique musical situation, it can however be seen as a micro-culture where two people intentionally exchange musical styles, sounds, ideas and forms. This being so, we hope to gain an insight into the socio-emotional, rather than the psychological needs used in our design example Hassenzahl (Hassenzahl, 2003) and Sheldon et al. (Sheldon, Elliot, & Kim, 2001), that is involved when pianists engage in collaboration, or transact, discuss, define, and interpret music together, and what motivates them to do so. By this we hope in bringing useful insight into the more intangible drivers not only of collaboration in music, but also collaboration in general, something which some researchers say is a very much viable endeavour[26]. This insight in turn will be used to not only build our prototype, but also be used for the design of any CSCW for music applications in general.

5.3.1 Socio-emotional needs in piano duets

An attempt to identify musicians needs of engaging in piano duets was made by interviewing a set of pianists from Escola Superior de Música e Artes do Espectáculo (ESMAE) in Porto, Portugal and Academy of Performing Arts in Prague, Czech Republic. The interviews were of an informal nature and served not so much for the basis of new findings as the validation of existing research in psychology of that area that the author was led to during the interviews.

In this process we found that previous research has identified relationships we see in piano duets as driven by needs of a socio-emotional nature (Blank & Davidson,

[26] See more attempts, but for Jazz improvisations by Sawyer, K. (2006). Group creativity: Musical performance and collaboration. *Psychology of Music* , 148-165.

2007). Defining these proved useful in understanding CSCW for music applications and collaboration in general.

The first and also most significant of these needs, both according to our interviews and Blank and Davidson(2007), refers to the "pleasure of working towards producing a performance" Which includes choice of time, venue and repertoire, rehearsal procedure, interpretive and technical aspects etc. Further goals according to Blank and Davidson include the desire to "contribute to a larger musical picture" (2007, p. 242) and seem central to the experience of not only piano duets but also music praxis in general, and is what Tanaka refers to as a sense of musical *agency*. Another identified socio-emotional need involves coordinating your playing well with another pianist achieving *synergy*, where arrangements develop a "phantom" element - a "third hand" or collaborative identity where the individual styles of the pianists to meld into one performance (Green, 2001). Following needs are those which threat the piano duet as a social meeting point allowing musicians to develop friendships through the enjoyment of working with someone else (Blank & Davidson, 2007, p. 242). Even the reassurance and confidence that comes with a shared experience is definitely one of the psychosocial needs of duets[27].

Some of the more practical needs, annexed to the socio-emotional, include "creating arrangements of greater complexity". Just as some written works can be complex and thus inaccessible to individual players, playing a duet allows access to a larger repertoire (i.e. explore the operatic, symphonic and chamber music repertoire) (Weekley & Arganbright, 2007). A more practical need, although also emotionally

[27] Also *apprenticeship* is mentioned as a sub-goal as the musical outcome, intertwined, rewards less experienced people with confidence.

based is that duets allow a musician greater opportunities for performances as those are in limited demand for soloists (Blank & Davidson, 2007, p. 243).

As we have identified these need-based goals of musical collaboration as *pleasure working towards a performance*, *contribute to a larger musical picture, synergy, social meeting point, creating works of greater complexity*, an interesting prospect is that they can be turned into "experience-patterns" (Kim, Park, Hassenzahl, & Eckholdt, 2011) bridging them from abstraction into concreteness in products, services or activities to inform the design process of collaborative music systems, and must be one of the more exciting prospects for the future of the research area. However, as we won't go this in our research, we will rather investigate the role of some of these in a prototype.

Concluding our findings of pianists' socio-emotional needs in piano duets, we realize the importance of "the concert" at a certain time, in a certain venue and to engage in it with other people. Also that this process constitutes a social meeting point where users transact various issues relating to the concert in a verbal, visual and musical way. The chance to produce greater complexity of a musical artwork is naturally a cornerstone of engaging in piano duets and a final need (and maybe most interesting to experience design research) transcends that which experience design call "belonging", put in musical terms – "contributing to a larger musical picture", something which doesn't merely equate to "the more, the merrier", but rather that **complementary styles, sounds, ideas and forms are *central to positive experiences*** – be it between humans, or humans and machines for that matter. The closest previous research in experience design comes to highlighting the innately social nature of our most positive experiences are is in *relatedness* (Sheldon, Elliot, & Kim, 2001), *intimacy* (Gaver & Martin, 2000) or *popularity* (Kim, Park, Hassenzahl, & Eckholdt,

2011), that however all fall short of explaining some of the more **creative** or **bisociative** experiences users look for in designed products, services and events.

To design and test for some of these piano-duet derived needs, and to initiate experience design thinking in NIME, these were translated into user goals addressed by affordances of a prototype. Our prototype "interfacing" composers in cohort with remote audiences provided a concert venue, a time, a social meeting point of sorts and the ability to be part of a bigger musical picture, also to produce a work or greater complexity, if now a concert can be seen this way. Now, naturally these affordances provided by our system, does not address the needs in piano duets adequately to 100%, such a thing is impossible, however we still find that our first prototype was sufficient in revealing the appeal of *performance venue*, *audience*, a *joint concert* and *technologies* used, among our users. (Makelberge, Barbosa, Perrotta, & Ferreira, 2012).

Chapter 6

Design and Implementation

6.1 Enter Perfect Take

"Perfect Take" is intended as a public installation out of networked acoustic instruments and a website that let composers from all over the world have their music played for an audience by means of MIDI. The primary aim of this system is to offer composers a way to have works distributed and recorded with other composers in venues and for audiences with technologies not accessible to him/her under normal circumstances. The design of this system followed an *experience design* approach that traditionally aims at broaden the research concerns, design and development perspective of interactive products and systems. Together with usability and *interaction design*, experience design has been argued to be a more holistic point of view in the analysis and design of human-computer and human-human interaction, including a greater emphasis on the time and space dimensions of experiences with technologies. (Mulder & Terrenghi, 2010, p. 195) (Blythe, Overbeeke, Monk, & Wright, 2004) (McCarthy & Wright, 2007) *Experience design* argues that when technologies enter our daily environments and activities, the way we experience them is strongly related to our physical, social and cognitive context, which implies that ergonomic, or usability as well as social and psychological dimensions need to be addressed in the design and evaluation of the product/service. Experience design has therefore emerged as a compliment to address less tangible and measurable qualities of designed products - qualities that ultimately make them successful and highly useful to users, rewarding them with a positive user experience.

Designing our system therefore included a shift of focus from functionality of a specific gestural controller *per se* in music, towards the environments, events and processes that they are part of - as these strongly relate to the socio-emotional needs and motivations of users as defined from piano duets in the previous chapter. This included fulfilling the need *to work towards a performance*, *contribute to a larger musical picture, synergy, provide a social meeting point, creating works of greater complexity*[28]. These socio-emotional needs are similar to needs identified in research in design (Hassenzahl, Platz, Burmester, & Lehner, 2000) (Hassenzahl, 2003) (Kim, Park, Hassenzahl, & Eckholdt, 2011) in the field area of "psychological needs-driven experience design".

As a first prototype, PT utilizes a Disklavier piano by Yamaha, however aims to in the future involve a NotomotoN (Kapur, Hochenbaum, Darling, Diakopolous, Murphy, & Trimpin, 2011) (a robotic drum featuring twin drum heads, a metal body, and 18 solenoid beater assemblies) and other MIDI-operated instruments in an attempt to create an interesting ensemble. The ideas for a system like PT came out of the will to open up studios and public spaces at the Research Center for Science and Technology of the Arts (CITAR)[29] and ultimately cultural institutions such as Casa da Musica[30] in Porto, Portugal for music-makers from around the world.

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[28] The functionality addressing some of these needs is quite limited. Nevertheless, the prototype devised was sufficient as a starting point to investigate the area of needs-driven experience design in NIME.

[29] http://artes.ucp.pt/citar

[30] A multi-venue performing arts centre.

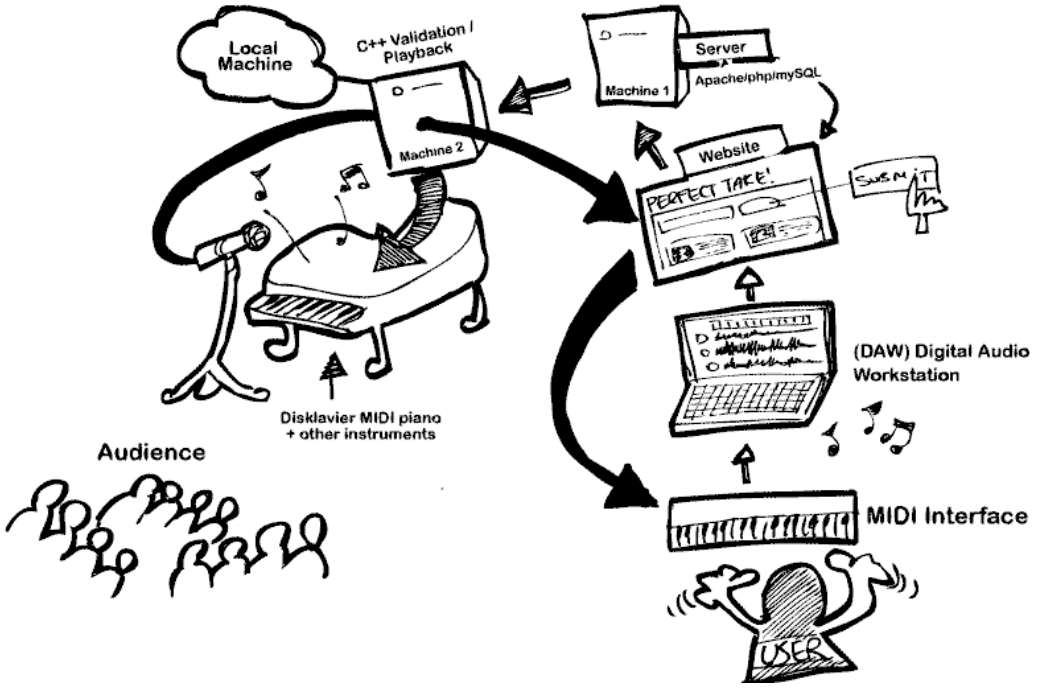

Figure 9. The Perfect Take system sketch

As we employ a Diskalvier piano as the main musical generator and output, it could be in place to talk a little bit more about this unique instrument and its qualities.

6.2 The Disklavier

Disklavier is the brand name for a group of piano-related products by Yamaha Corporation introduced in the United States in 1987. The various forms of Disklavier are essentially modern pianos that employ electromechanical solenoids and optical sensors connected to Light Emitting Diodes (LED) allowing these to play the keyboard and operate the pedals unaided of any human performer. Most Disklavier-models are based upon real acoustic pianos and are engineered in a way that the sensors and electromechanical elements do not interfere with the operating of the instrument. Features include the ability to store data including that of performances played by any human pianist. This data subsequently may be used to reproduce performances. Various modes of input of data include that of MIDI-out cables and

storage devices including Universal Serial Bus (USB), floppy disks, CD-ROM and serial cables. Disklaviers are manufactured upright, baby-grand, and as a grand piano, along with a product aimed at the professional market called the Disklavier Pro which is claimed by the manufacturer to be able to reproduce key and pedal strokes with greater accuracy than the regular Disklavier instrument[31].

By means of the Disklavier IV, Yamaha launched a project providing for data communication between two or more pianos with the intent of supporting real-time, remote classes and collaboration between pianists. For this, Yamaha produced "Remote Lesson", a software application that we have already mentioned, that has proven to successfully connect two Disklavier pianos separated by several thousand miles using Internet2 connection, as well as more traditional connection methods such as T1 and DSL protocols. The “Remote Lesson” therefore employed in reproducing the actions of one player on one Disklavier on another, connected remotely using high-speed broadband. As expected however, speeds of data-transfer generally available for the public is currently deficient for latency-free, real-time operation. Delay in these scenarios is unavoidable of at least one to several seconds between pianists. Another reason for this is that MIDI data is buffered within the Disklavier, due to internal timing and velocity interpretation – which is another reason for the unavoidable delay between two or more users connected remotely. At certain instances, videoconferencing has been employed as an addition to the communication between pianists. Although currently “Remote Lesson” has not been released to the general public, it is said this feature as a software upgrades for future pianos.

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[31] http://usa.yamaha.com/products/musical-instruments/keyboards/disklaviers/

6.2.1 Velocity Dependant Delay

The biggest challenge with the Disklavier piano and with solenoid-based robots controlled by MIDI commands when it comes to delay and latency in real-time networks and performance is not only the intrinsic delay that any of the solenoid has, but rather the unavoidable *velocity* dependent delay, in other words the velocity or the speed or force a note has been struck influences the delay, so that quiet notes take longer to play than loud ones. The reason for this "velocity dependant delay" in MIDI is because the reception of a command to play a note is the initiation of the process that strikes the string or drum. It follows naturally therefore that a slow moving solenoid is moving slower, also sounds more quiet, but as a result also takes longer time to arrive at the object it is striking. This naturally means that a constant velocity will keep a consistent delay, however most natural sounding performances vary in velocity, which will produce serious discrepancies in delay and will sound out of rhythm. On the Disklavier therefore, Yamaha solved this issue by first assigning a 500msec delay to any MIDI input, and then correcting for the velocity-dependent delay on the Disklavier system. 500msec seems to handle even the worst delays induced by the lowest velocities which produces an elegant and effective when playing from recorded sequence of MIDI, where the "performance" is invisible, however for live performance, and performers triggering the events this looks awkward not only for the audience, but also for the performer who is accustomed to instant result of his musical gestures and actions. The Disklavier allows this functionality to be switched off, however then you are left with the initial problem. At this moment, there seems to be no solution to this problem as long as one is dealing with the MIDI protocol although having some sophisticated sensing that can "predict" how fast the performer's hand is moving is one option that would imitate the

instinctive anticipation pianists seem to have to strike keys so that the hammer of quiet notes arrive at the string at the same time as loud ones. (Kapur, Eigenfeldt, Bahn, & Schloss, 2008)

As said, these issues relate mainly to synchronous performance, and not so much on asynchronous, which is the case with our prototype PT. The reason for choosing an asynchronous system is its advantages, which are many and unique and differ from real-time systems.

6.3 Advantages of the asynchronous

All forms of creativity, in groups or by individuals have some definite advantages of an asynchronous creative process as opposed to the synchronous. An asynchronous creative process in music necessitates that musical ideas are recorded in form of a score, MIDI or sound sample to be gestated, worked over and perfected before presenting it as "the work". Various "recording" technologies that freeze our ideas in time therefore, have therefore temporally emancipated us from fleeting moments and ideas, and allow for the creative process to span a longer time, many takes, and many layers with ample opportunity for new insight to emerge, either for an individuals or people in group.

In this section therefore we will go through these advantages, and also some of the disadvantages by first looking into CSCW followed by the impact it has both individual and group music creation.

6.3.1 Advantages in CSCW

Research in CSCW has shown that computer conferencing systems, initially designed for synchronous and asynchronous work are almost exclusively employed in the

asynchronous mode, showing that "*users nearly always choose the asynchronous mode for serious interchanges*" (Barbosa Á. , 2008, p. 9). Now, what *serious* really constitutes can be elaborated on, however the advantages afforded by asynchronousity are often one of the main motivations for using computer conferencing systems. One of the first being the *time* issue, all participants does not need to be active simultaneously. In this sense it offers flexibility as participants can lag behind in discussions and still be able to contribute to the work. A second is coercion and time pressure; participants are allowed to be thoughtful and not forced to rush decisions because of time pressure. This provides time to collect facts, reflect and way different options. A third advantage is in the individual pace of participants, some prefer more time than others to read and reflect on problems. (Barbosa Á. , 2008) It is legitimate to assume therefore that these advantages should exist for collective scenarios of music creation.

6.3.2 Advantages in Music

"*As the temporal characteristics of networks posed significant musical challenges, I began to question whether networks were not better suited for musical activities other than real-time performance*." (Tanaka A. , 2006)

At first sight, the prospect of having your music rendered in a group concert, rather than performed in real-time over the Internet seems less interesting in a world of instant communication, however, the advantages of an asynchronous system are manifold and similar to those listed by CSCW. And the interesting thing about these are that they do not only apply to group creation, but also individual creation. As part of a group we reflect, edit and decide on ideas of group members in a reciprocal

fashion, while in individual creation we use ideas we appropriate or have come to ourselves. Both these scenarios are benefitted by more *time* to reflect and edit and way options, less *pressure* to make fast and forced decisions and allows for individual *pacing* of work. In this sense, PT supports asynchronous creativity on both the individual and collective level. For individual creators, PT provides a platform where carefully crafted musical compositions are presented in a remote venue to an audience. This gives users time to *reflect, edit* their work under less *pressure* and work at more complex compositions at their own *pace* before being submitted. Even on a group level users are not coerced and have time to choose what music to add. This allows for an gestation process that is not present in real-time, improvational performance.

The advantage to gestate music by externalising it in some recorded media is as old as musical notation itself, and readily apparent when staff notation emerged in Italy during the middle ages[32]. Musical notation "*allowed* [western classical] *music to become more polyphonic and complex than an oral tradition could sustain*." (Ball, 2010) as "[i]*n an oral tradition, all cultural representations are easily remembered ones; hard-to remember representations are forgotten, or transformed into more easily remembered ones, before reaching a cultural level of distribution*" (Sperber, 1996). Mozart is also said to have been using a well worked out system of sketches on paper that he kept in his *Verzeichnüss aller meiner Werke* ("Catalogue of all my works"), and often relied on a keyboard to work out his musical thoughts (Konrad, 2006). Probably because of the same advantage Frederic Rzewski is mentioning:

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[32] Guido of Arezzo, an Italian monk and music theorist was the first to map note names to parts of the human hand as mnemonic aid for Gregorian chants.

"[I]*n composition you have all the time you want to think about what to say in fifteen seconds, while in improvisation you have only fifteen seconds*." (Cox & Warner, 2004, p. 267)

Western musical culture has thereby been able to produce highly sophisticated organizations of sound with large-scale forms and large ensembles, much thanks to the development of notation. This has however been made possible at the price of dividing music into a "score" and a "performance" part, where the score is essentially made up of a set of symbols for discrete actions, i.e., certain tones of certain durations to be played at certain points in time with approximate intensity on prescribed instruments, sometimes with various metaphorical labels for intended expressivity.

Further examples of externalising musical ideas I an attempt to "perfect" music can be seen in Canadian pianist Glenn Gould, who at advent of recording technologies spliced together several recorded takes in to a perfect one, in his quest for perfection(Hecker, 2008). As an interesting consequence, recording technologies like notation, MIDI or recorded sound as in the case of Gould, also reward novices with the ability to achieve a more agreeable musical result in their compositional process than in a live performance, and thereby provides Wessel and Wright's much desired ideal of "low entry fee with no ceiling on virtuosity" of interfaces for musical expression (Wessel & Wright, 2002), something that could benefit NIME to investigate further.

Other advantages and disadvantages of asynchronousity and of our system specifically concern that of replacing the performer. Presenting recorded music through the MIDI protocol not only has certain advantages over live performance, but also over traditional forms of musical notation in the sense that it eliminates the

performer from the traditional triad of western classical music: composer, performer and audience (Katz, 2004). As MIDI information does not require interpretation, it circumvents traditionally sensitive issues such as "score compliance" (Goodman, 1968) (the duty on behalf of any performer to comply with the notation) or authenticity of a performance. Naturally, elimination of the performer may also be seen as disadvantageous as any interpretation, or the subtle shadings of personal intonation - nuances of pitch, duration, volume and timbre is not perfectly rendered by the MIDI protocol, it however allows works to be as close to as possible as intended by the composer.

Performance gestures

Replacing the performer omits expressive gestures of performance that normally part of a live, visible performance, which naturally can be seen as a disadvantage. Ancillary, communicative and sound-facilitating gestures are all are part of an expressive performance (Godøy & Leman, 2010). *Ancillary* gestures are idiosyncratic gestures musicians do that do not have a direct impact in the production of sound, but are still considered a necessity by the performer. *Communicative* gestures communicate; express any extra musical things to the audience or fellow performers. *Sound-facilitating* gestures follow features of the sound or music produced, like dancing to a beat. All these does not necessarily contribute to the music, however they do matter to the expressiveness of the performance and is obviously lost in musical systems void of any human performers like in PT.

Mutual adaptive behavioural resonances

Another disadvantage, as a consequence of omitting gestures from the performance are the "mutual adaptive behavioural resonances", or *entrainment* where the audience merges with actions and goings-on not only in the music but also up on stage, and brings with it a certain magic to live performance (Leman M. , 2008). Entrainment tends to have a positive effect on performers and their playing and the lack of it is clearly one of the disadvantages of asynchronousity such as in PT.

6.4 Implementation

6.4.1 Design strategy

Designing Perfect Take involved several design conversations with both composers and technically knowledge people involved in the project. In these design conversations sets of requirements were gathered and defined, both of a technical and non-technical nature, so as to define the scope of a first prototype. The non-technical related to what the system would be able to do in user experience terms, while the technical related to what we needed technically to provide such experience, or what the system needed to be. These requirements were in turn turned into a clickable design mock-up that aimed at visualize the user experience of the PT system form a user, audience and administrators point of view. The mock-up also worked as a tangible, visual form of the requirements, making issues concerning of the ideas of stakeholders visible to the development team. In that sense it served as a shared canvas, or "boundary object", a shared taxonomy or conceptual object (Star, 1989) where design discussions could be exercised and kept within scope.

6.4.2 Design Mock-up

A mock-up of PT was designed in Axure[33] prototyping software that through style templates allows you to quickly build interactive prototypes. This mock-up served as a tangible version of the functional specifications defined through design dialogues with stakeholders and based on interviews[34].

[33] http://www.axure.com

[34] For the full clickable mock-up please refer to: http://share.axure.com/941Z8M/ , Password: ucpucp

Front-page

The front-page (Figure 10.) consisted of a succinct value proposition and clear incentive to action. From the front page visitors have a easy access to a PT twitter-accounts, flickr photos from sessions and various "share" functionality for social and contextual user experience in promoting the system and recording sessions in various social media. Information concerning the project, people involved and contact information is also provided.

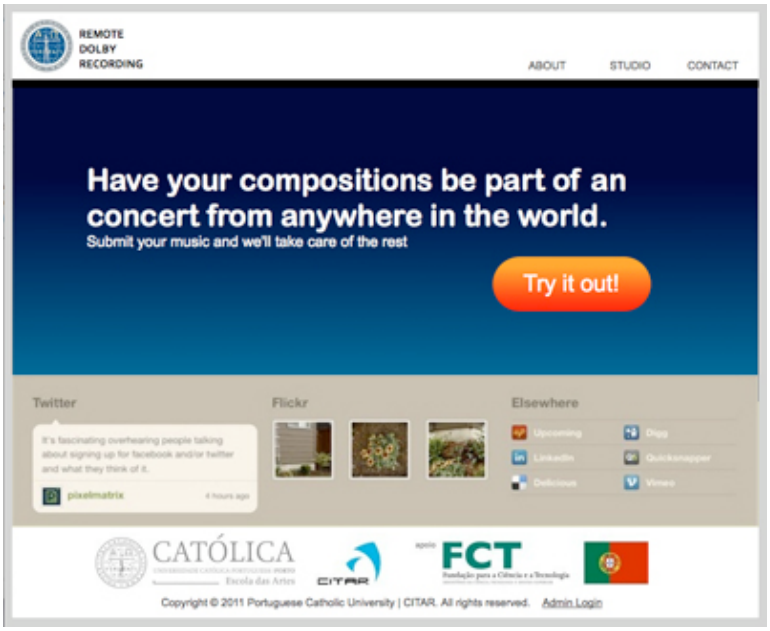


Figure 10. Design mock-up of the front page

Register / Login

On the register and login-screen (Figure 11.) users had the option to either create a new user account, or login using social networking site Facebook. This would help in simplifying and enhancing user registration and sign-in by using Facebook as a login system. By this, users no longer need to fill in yet another registration form or remember another username and password to use for PT. As long as the user would be signed into Facebook, they would be automatically signed into PT as well. Using Facebook for login in this sense would provide all the information needed to create a social, personalized experience from the moment the user visits PT in their browser.

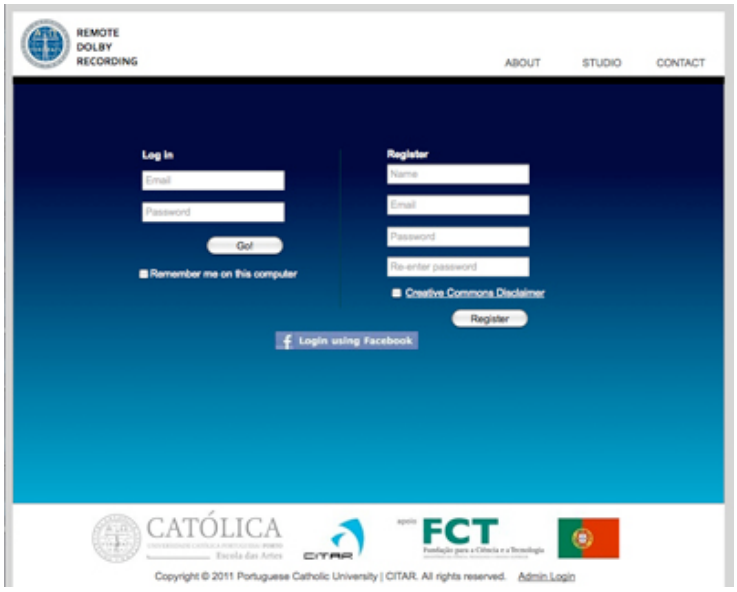


Figure 11. Design mock-up of the login/sign up screen

Stack

Once logged in (Figure 12.), users would be taken to the "stack" where they see submitted works (if any) and add, edit or delete his/hers own work of music. On this page, bibliographical information is provided concerning the musicians backgroud, whereabouts and musical work together with work name and duration. Information concerning the session is also provided regarding microphone placings and other parameters that will affect the final outcome of the artwork.

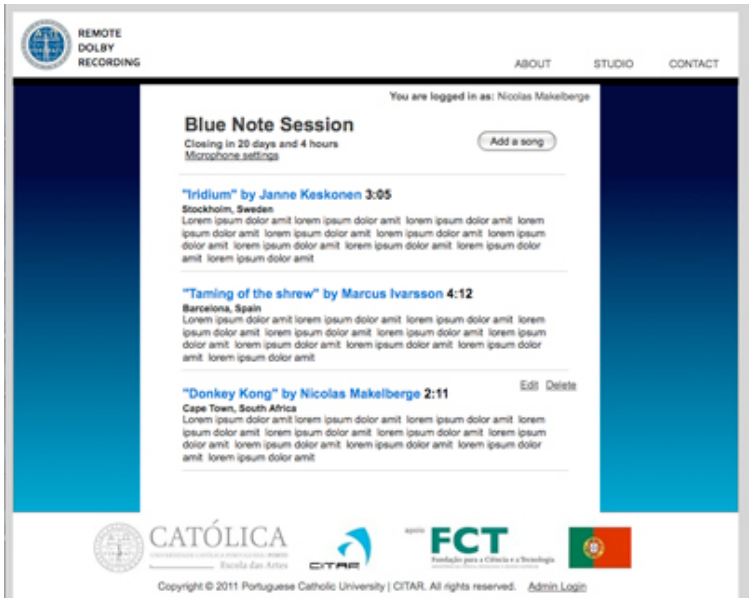


Figure 12. Design mock-up of submitted works as seen by a users

6.4.3 Technical implementation

A first version of PT was developed and consists of a website where users register and submit MIDI files to a server running Apache, PHP and a mySQL database. Submitted files are then validated for correct format and track number and sorted by an application written in C++, openFrameworks7 and the "libjdksmidi 2004" C++ Class Library for MIDI8. Once the files are validated they are added to the client-side stack. A similar interface is provided to the audience in form of a conference program, similarly including biographical information like name, location etc., of a submission.

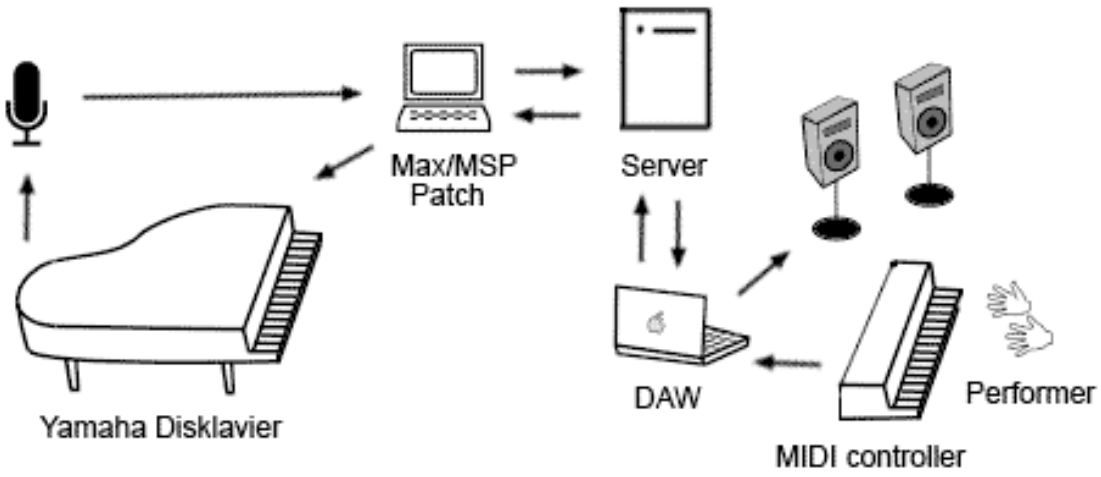


Figure 13. A Perfect Take system diagram

MIDI playback and stereo recording of submitted music is done through a Max/MSP patch (Figure 14.) that furthermore functions as an administrator interface subsequently sending the resulting Audio Interchange File Format (AIFF) files back to the server where they are accessible for both users and the general public. The

server and processing run on separate machines to allow the system to be open for MIDI-submission around the clock.

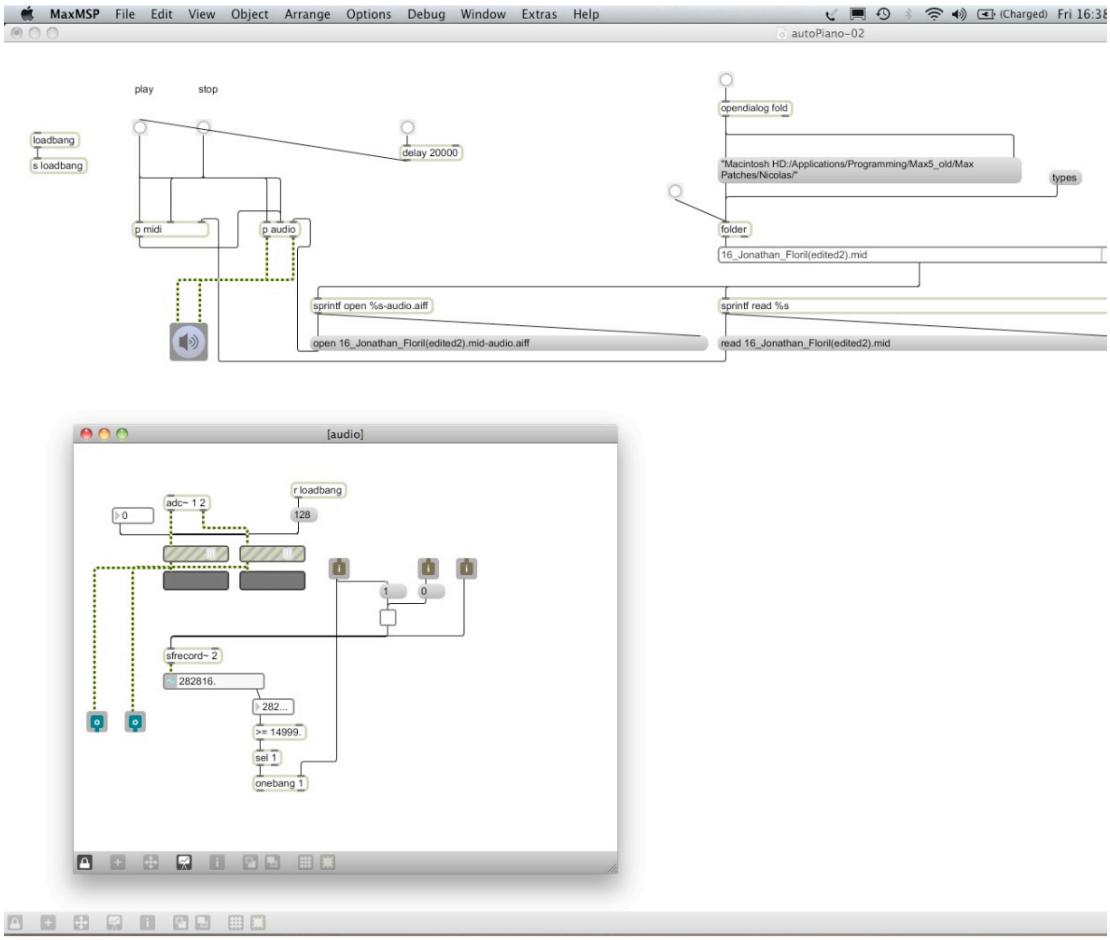


Figure 14. MAX/MSP Patch devised for administrating Perfect Take.

6.4.4 Functional Implementation

The functional implementation PT relates to its use by administrators, musicians and audience. For *administrators* this included sending out invitations to participate in what was advertised as “sessions”. These were intended to vary according to what MIDI instruments, microphones; polar patterns (Bi, Uni or Omni-directional) were part of the ensemble in future sessions. For the Disklavier, this included parameters that would influence the character of recordings of acoustic instruments like where on

the high and low ends of the harp plus proximity to the hammers microphones are placed[35]. If the top of the grand piano were “down” or “off” that would affect overall sonorities, which would have to be experimented with. In the first version of PT however only a Disklavier piano was employed recorded by a pair of Omni-directional AKG ck92’s creating a neutral sounding stereo image. Other implementations for administrators included the administrative interface in MAX/MSP[36] (Figure 14.) to access submitted files from the server, send it to the Disklavier and record the result once all the equipment is set up.

Figure 15. Testing session + Notomoton

[35] Closer proximity produces a more distinct, sharper or brighter sound as opposed to a warmer and rounder.

[36] http://cycling74.com/

Despite not all *musician* functionality from the design mock-up made it into the first prototype version of PT, the most essential did; that of a way for users to create an identity, submit a work through an online form, have it recorded in a remote cohort session on the Disklavier and subsequently have access to their own and their peers recordings on a server. This allowed us to test for the most immediate issues of our system, relating to the experience of having access to a remote *venue* and *audience*, *joint concert* and *technologies* too see what needs to be in future versions of PT to improve the user experience.

Functional implementation for the *audience* was limited in the first round of tests in a closed setting, with few people present together with the administrator. As we initially evaluate the use of our system from a musician's standpoint, evaluation of audience experience will have to be something future versions and test will have to address.

Figure 16. Example of a Perfect Take concert

6.5 Evaluating the user experience of PT.

6.5.1 Methodology

"*Sound and Music Computing (SMC) research approaches the whole sound and music communication chain from a multidisciplinary point of view. By combining scientific, technological and artistic methodologies it aims at understanding, modelling and generating sound and music through computational approaches* [...] ***Artistic methodologies*** *refer to approaches that explore human experience and expression*." (Bernardini, De Poli, Serra, Leman, & Widmer, 2007, p. 9)

In the roadmap for SMC 2007, trends of within this area of research is outlined and deals to a great deal with the value of interdisciplinary research and specifically for humanistic research such as artistic methodologies, to provide the analysis of the social and cultural context in which technological applications will function. It is argued that as subjective factors (such as experience) play a central role in how people deal with technology (Bernardini, De Poli, Serra, Leman, & Widmer, 2007, p. 22). In short, humanism and the arts provides a very rich background from which the problem of the content, meaning and purpose of music may be defined, providing a foundation that guides the development, and employment of sound and music technologies. The SMC roadmap states:

"*Humanities research provides the necessary analysis of the social and cultural context in which technological applications will function* [and] *offer the cultural background and content for SMC research*." (2007, p. 22)

It is argued that this will bridge the "semantic gap" between our daily meaningful experiences with sound and music, that deals on the one hand with qualities, and the encoded physical energy of sound and music that deal with quantities on the other. The methodology employed in both designing and evaluating PT follows the former, through a user experience evaluation to find what in particular is "*satisfying about satisfying events*" (Sheldon, Elliot, & Kim, 2001), from a subjective first-person perspective. Before we go more into our evaluation, let us have a look at some methods of evaluation existing systems and instruments in NIME to date.

The evaluation of traditional gestural controllers and NIME's has proven difficult due to the complex nature of the experience of music making that resists being systematized into tasks that can be measured quantitatively, nevertheless some authors have proposed a framework for the evaluation of digital music instruments where, depending on the perspective on the design, various stakeholders such as audience, musician (performer/composer) and designer, differently evaluate and shape the final design (O'Modhrain, 2011). Some researchers have rather turned their focus towards methods in HCI including Wanderley and Orio (Wanderley & Orio, 2002) who proposes a qualitative approach for evaluating interactive musical systems, an approach that centres on a series of minimal required musical task users need to perform. These tests were then followed by a self-assessment of performance expressed on a Likert-scale[37]. Kiefer et al. (Keifer, Collins, & Fitzpatrick, 2008) found out through the Wanderley and Orio approach that qualitative analysis through interviews to be more useful than quantitative data concerning things such as task accuracy.

[37] http://en.wikipedia.org/wiki/Likert_scale

In line with these findings the HCI community, and NIME have both addressed the lack of paradigm able to fit the domain of *experience*, or "non task-oriented computing" (Harrison, Tatar, & and Sengers, 2007) that is to say, interactive artefacts which's operation is guided more by a quality of experience and emotion associated with it than a traditionally quantifiable usability goal. One example of this can be seen in an ambient display that is designed to convey more of an experience than merely a set of facts to a user.

"*It is difficult, for example, to apply usability studies to ambient interfaces, since standard evaluation techniques are 'task-focused' in the sense of asking users to pay attention to and evaluate the interface, precisely what the system is devised to avoid*." (Harrison, Tatar, & and Sengers, 2007).

In the light of this, a third paradigm of HCI has moved focus from usability to embodied interaction[38], dealing with meaning and meaning construction. In NIME some research focusing on the conceptualizations users have of musical interfaces includes Stowell et al. (2009) who proposes an evaluation method based on an adapted version of Discourse Analysis (DA), a method that focuses on the linguistic content of the verbal exchange, or the text. Another qualitative methods based form of analysis is presented by Johnston by practice-based research in new musical instrument design (Johnston, 2011) whom argues that a more appropriate term than "evaluating" a musical interface is rather "user experience study" as the former is best

[38] A coherent framework for analyzing the production of meaning and the organization of social interaction in the complex and heterogeneous settings that are characteristic of modern life.

seen as a component of a broader examination of both musical interface design and musical expression.

Our approach is just this, a user experience study - in line with these qualitative attempts of evaluation. We do this through having a group produced concert recorded and provide questionnaires and conduct interviews to find out about how the needs and motivations of users using PT are fulfilled, some of them socio-emotional as it is a group concert, a needs fulfilment that can be seen as Key Performance Indicators[39] (KPI), or primary determinants of the quality of the PT experience.

6.5.2 User Experience Studies

The main evaluation of PT was conducted through the submission of works from a set of composers from various parts of the world, from varying background and experience. The music was recorded in a joint concert at Catholic University of Porto, Portugal. After the concert and recordings was shared through a website and a questionnaire was disseminated to all participants assessing the appeal of PT as a system. The questionnaire included a five point Likert-scale rating systems of the user experience and the various parts of the "value proposition" such as the appeal of a remote *venue* and *audience*, the *joint concert* and *technologies* used in the recordings. This got us to find out more about the distribution of these when using PT, insight that is valuable in itself, however ideally could be used to iteratively modify the value proposition and PT, or what Norman (2004) calls the *visceral* level dealing with

[39] http://en.wikipedia.org/wiki/Performance_indicator

instinct and first impression, followed by the *behavioural* level dealing with behaviour and use, and last the *reflective* level dealing with contemplation.

Our evaluation involved N=11 participants, all unpaid volunteers, 3 being female and 8 male, 2 were internationally recognized electronic musicians 5 amateur musicians and 4 professional pianists aged between 23-62. Participants were from 7 different countries and 3 different continents with a background varying from 0 to more than 40 years of composing music. Due to the degree of expertise among half of the participants[40], (one of which was a professional recording artists for Yamaha in the US), and the nature of our evaluation, we found that this was a sufficient number for a first concert and to provide us with detailed insight into the experiences of expert musicians with a remote concert system.

In our evaluative scenario, we informed participants that their works was to be recorded on a Disklavier in a studio at CITAR in Porto, Portugal and that the recording would be shared with fellow artists through the Internet. This value proposition naturally has less of an appeal for local musicians than for foreign, however, the technologies used when recording (the Disklavier, professional microphones, and studio venue still carries the same appeal). Therefore we applied a mix of evaluation methods including quantitative survey analysis and qualitative interview data analysis generated through the responses of the questionnaire.

It is important to note that in qualitative research many times emphasis is on generating, rather than validating theory (such as Grounded Theory) (Glaser & Strauss, 1967). Therefore, this research was intended to not prove preliminary theory, but rather provide insight into the experiences of individual musicians participating in

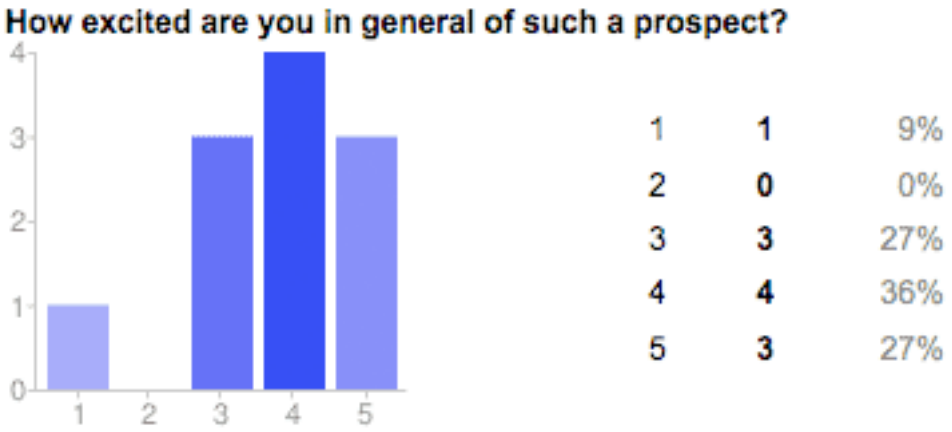
[40] Some who where players in professional symphony orchestras as well as leading improvisers

the evaluation, and on that basis generate some theories consistent with notions and observations made.

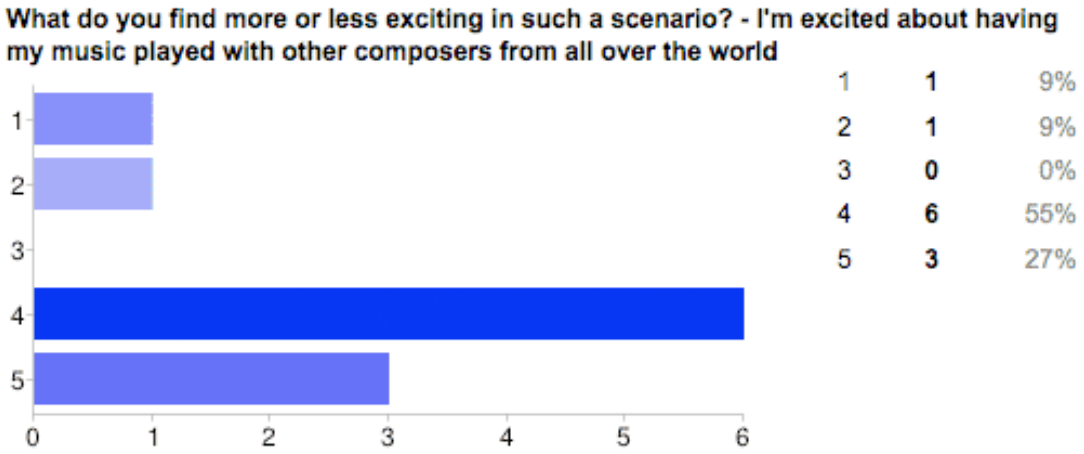
6.5.3 Questionnaires and answers

A questionnaire was deployed in this study to do a first-person, subjective user experience evaluation regarding the appeal of the *venue*, *audience, joint concert* and *technologies* when it comes to remote dissemination of music in a group. In it, users gave an overall rating of this experience in the three scenarios with a psychometric adjective-anchored "Likert" - scale, commonly used in qualitative research employing questionnaires. The answers are as follows:

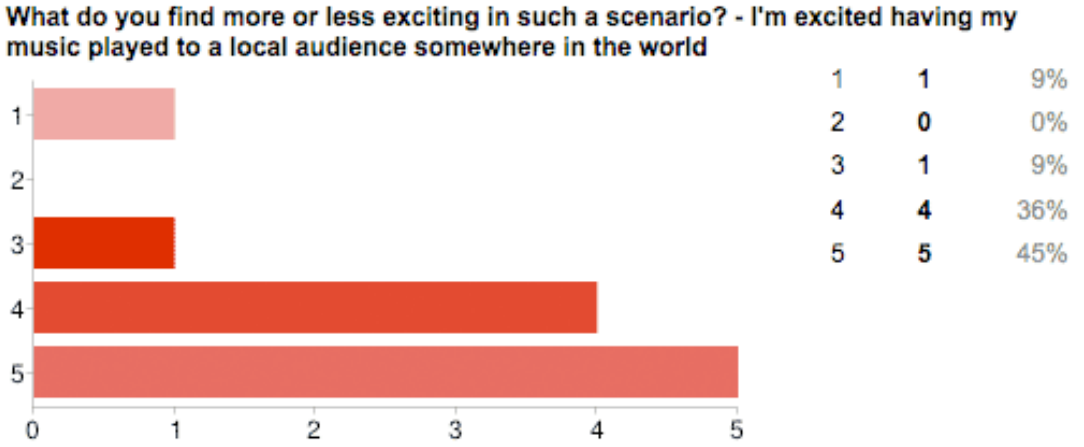
- 63% found that the value proposition in general was strongly to very strongly appealing.



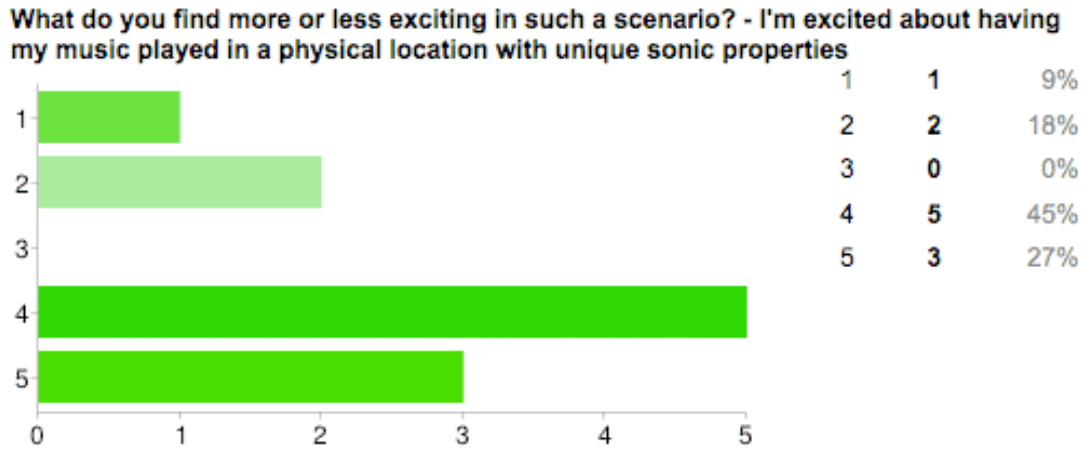
- 82% found that having their music played in a joint concert with other composers from all over the world, strongly to very strongly appealing.



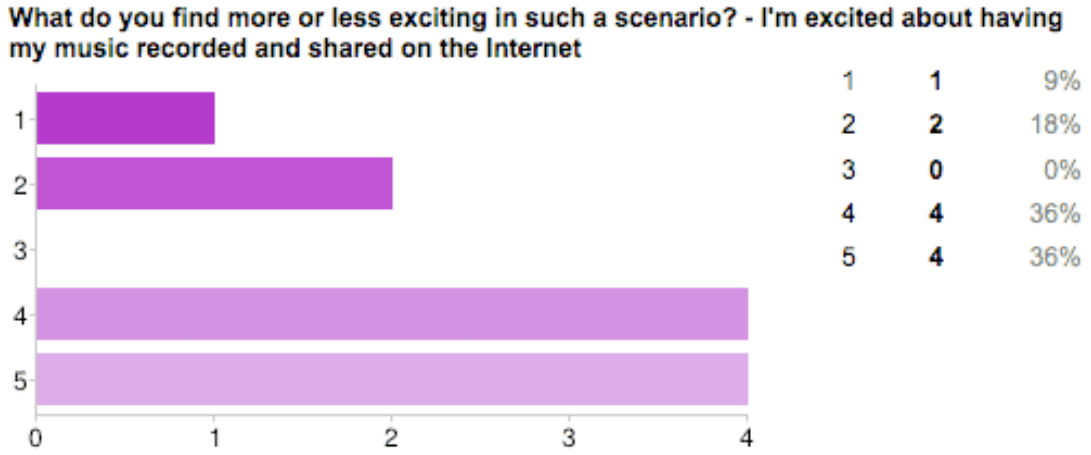
- 81% found that having their music played for a local audience was strongly to very strongly appealing.



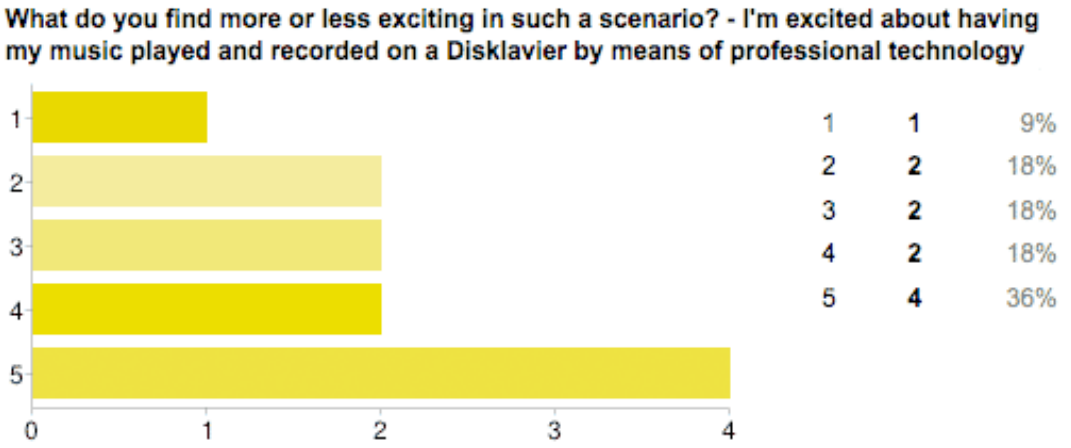
- 72% found that a unique venue, with unique acoustic properties had a strong to very strong appeal.



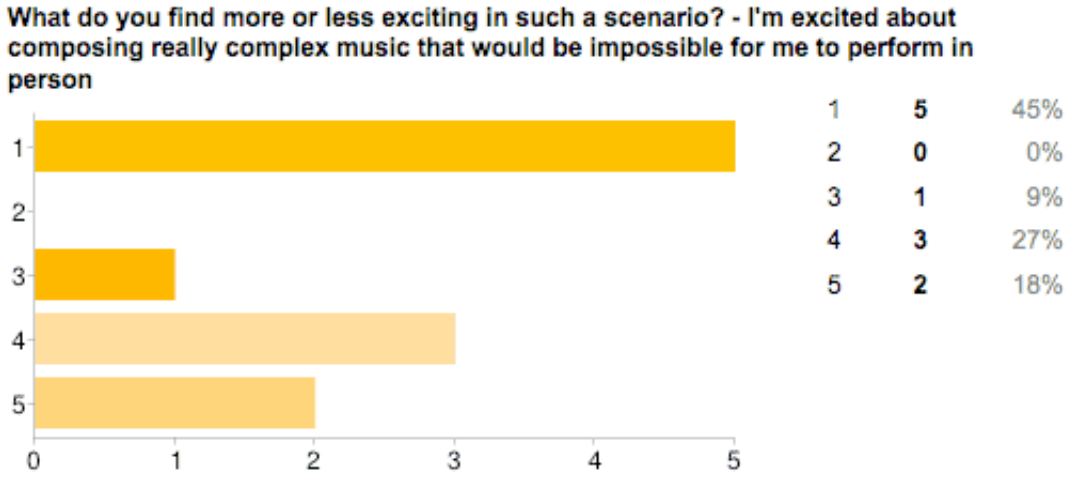
- 72% found to have their music recorded and shared on the Internet as strong to very strong appeal.



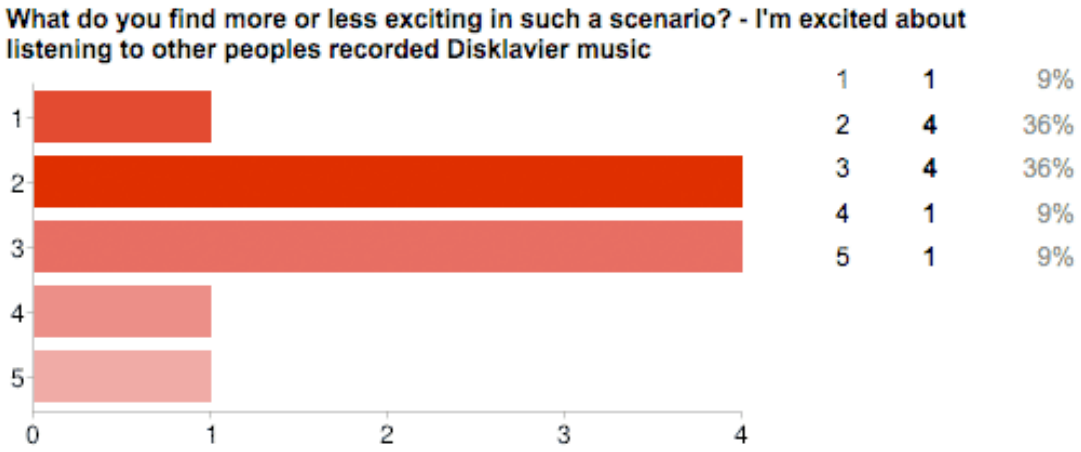
- 54% found to have their music recorded on a Disklavier to be strongly, or very strongly appealing.



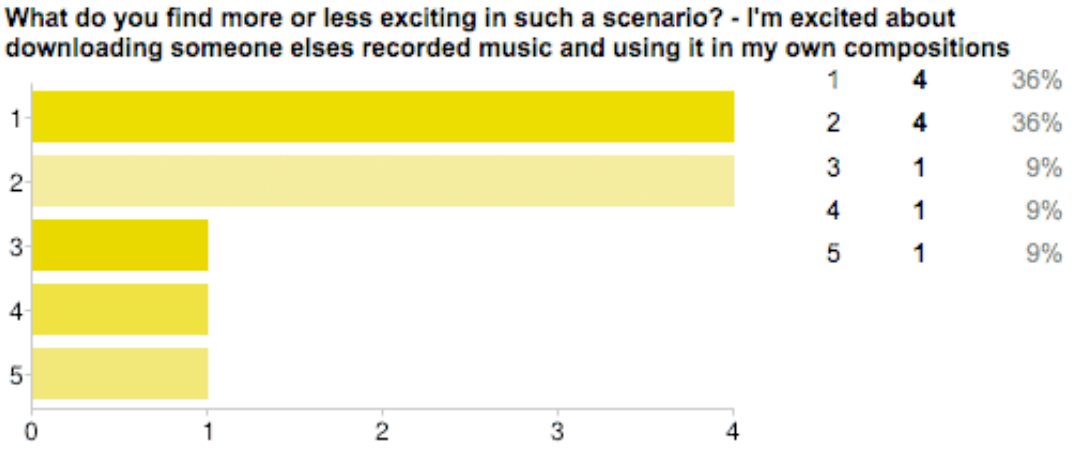
- 45% found the ability to write a superiorly complex works, impossible to perform live, to be strongly to very strongly appealing. (50% found it had zero appeal)



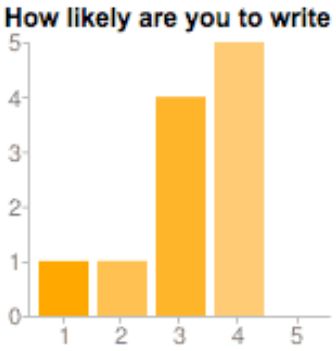
- 18% found it strongly to very strongly appealing to listen to fellow composers recorded Disklavier music.



- 18% found it strongly to very strongly appealing to download someone else's music and use in their own compositions.



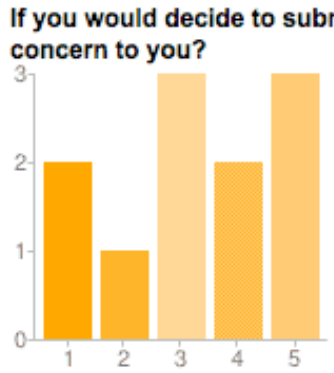
- 81% are fairly likely to likely to write and submit music for PT.



1	**1**	9%
2	**1**	9%
3	**4**	36%
4	**5**	45%
5	**0**	0%

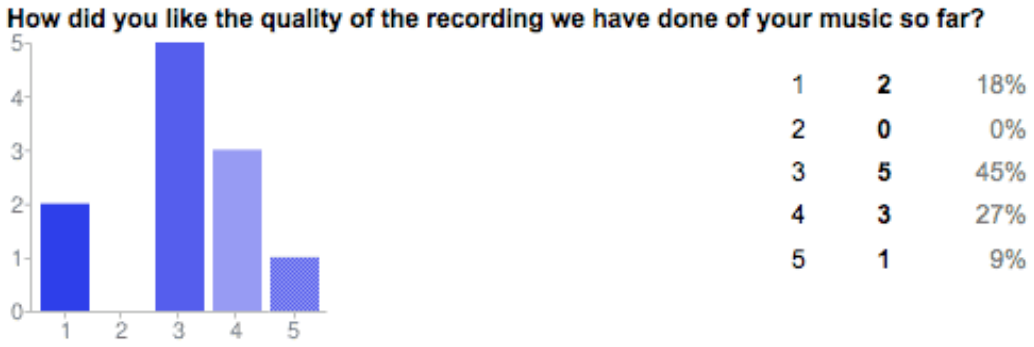
When it came to curate the concerts, only 9% preferred open-call concerts with no curator, 63 % said they maybe or would want to be responsible to curate a concert if the functionality was available.

- 72% of people find that the quality of music by fellow composers were of moderate to great concern.

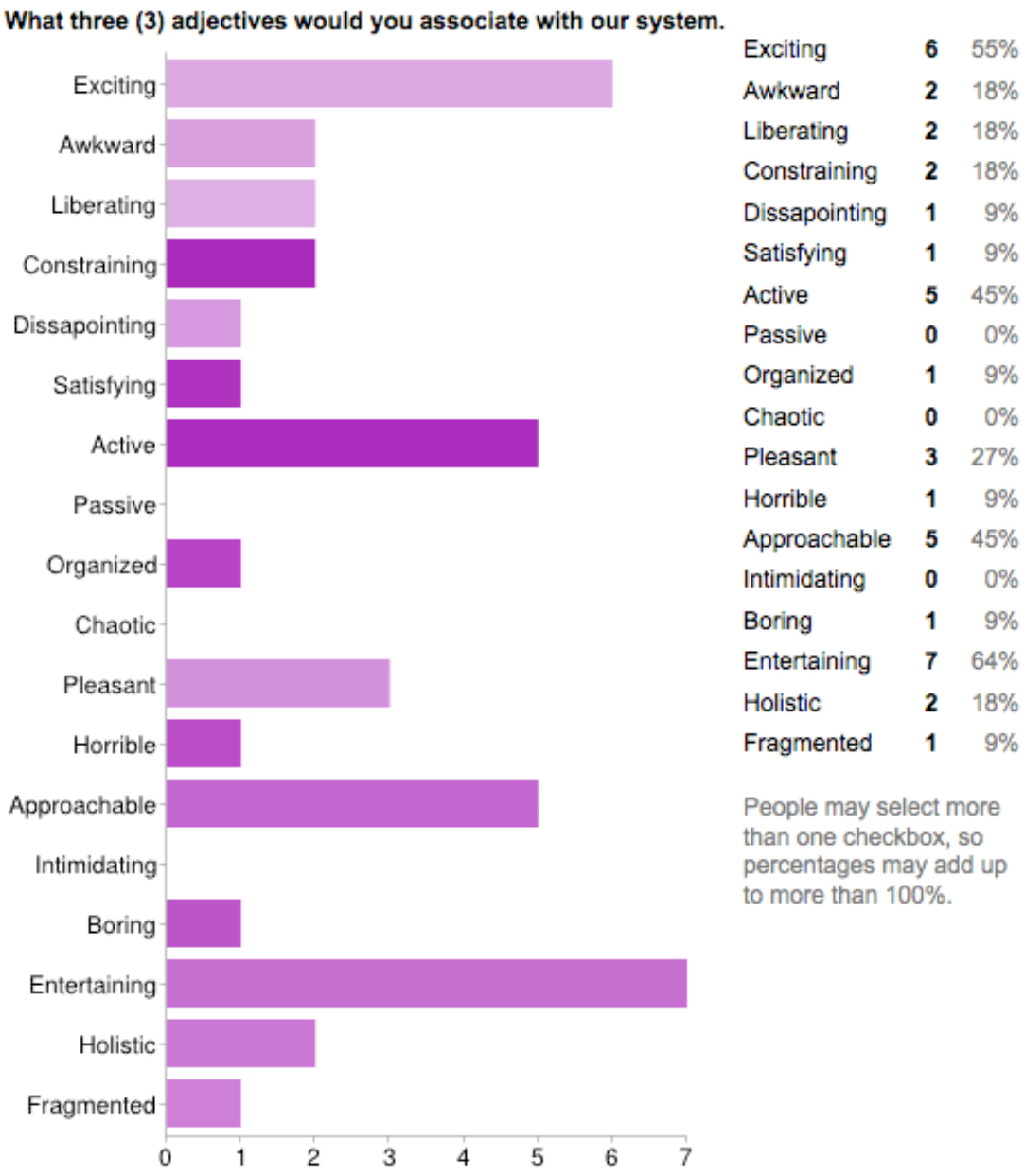


1	**2**	18%
2	**1**	9%
3	**3**	27%
4	**2**	18%
5	**3**	27%

- Only 36% of respondents register that they are happy or very happy with the quality of recording of their work on PT.



Additionally, in order to understand the quality of the main aspects from the PT experience, we asked the participants to select the 3 most descriptive adjectives from a group of 22 chosen by us as a mix 11 positive and 11 negative adjectives: *Exciting, Awkward, Liberating, Constraining, Disappointing, Satisfying, Active, Passive, Organized, Chaotic, Pleasant, Horrible, Approachable, Intimidating, Boring, Entertaining, Holistic and Fragmented*. Participants positively addressed the overall experience rating "Entertaining" the most relevant descriptor (7/11), followed by "Exciting" (6/11), "Approachable" (5/11) and "Active" (5/11).



6.5.4 Further comments from users

The goal of the wider comments was mainly to understand how users conceptually integrate the PT system into the context of use. These extended views from participants brought up many of the concerns you would expect to find in a project involving the MIDI protocol and Disklaviers.

Fidelity

The most common concerns brought up by users related to aesthetical and artistic issues such as the

"*loss of the fidelity in timbre, overtones, texture and dynamic nuances of an actual performance through digital recording and reproduction*". And although MIDI and Disklavier technology has its virtues it still "*far away from human mastery in the art of classical performance and the infinite nuances of sound production on acoustic instruments*".

However one could argue that the MIDI protocol captures much of the essential data of what a performer actually does to a Disklavier piano, such as: when, how fast (or gently) he strikes a key, for how long he holds it pressed, even how much pressure he exerts while pressing it (aftertouch) and of course when he releases it. In this sense, the timbre reproduced should be nearly identical to the original performance. In the same way, overtones are likewise recreated and the same with textures and dynamic nuances, especially if the MIDI is produced using a Disklavier.

On a variety of input devices for MIDI however, there will be discrepancies as the response is very differs from the Disklavier which results in some notes being very loud and some not being played at all.

Interpretation

Due to the lack of a performer, some raised a concern that related to interpretative issues.

"*Is it musically any difference from playing your MIDI in a DAW with a sampled grand piano? Is the quality better in any way does it make some emotional interpretation of the music in any way, MIDI-piano music can often seem a bit soulless without the interpretation*".

Although this is a valid concern, we believe that MIDI has excessively negative connotations among musicians. Works do gain in expressivity form a performer, however, that's obviously more essential in the case of a score where a performer is essential, than to MIDI. If artificial expressivity through some algorithm could be used however to add an interpretive layer on submitted MIDI-files is a very exciting prospect for future research.

Limitation in sound

"*It would be nice to expand the possibilities beyond the piano sound, maybe adding speakers for reproducing audio tracks and other electroacoustic instruments*".

This is obviously one of the main limitations, and opportunities of the system; the limited sound world to be explored. An limited sound-world might not sound very exciting compared to today's plethora of sound offered by DAW's, however, this can also be seen as an opportunity to expand the sound-world into both digital and acoustic, where users submit both controller data to instruments and digital sound files to be played together as one artwork. In such a scenario, opportunities for all forms of group creativity are vast.

Visual feedback

"*No video or other feedback*"

As the initial system provides a remote interesting venue and foreign audiences for most participants, to provide video recording or live streaming of concerts is also one of the more promising features that could improve the user experience.

Voting

"Maybe it would be interesting to have voting system for audience (something like on Youtube, but more exact)"

This would naturally be an interesting functionality to implement, and would reward composers with more feedback from the audience on their work. However, if this is still necessary once video is implemented will have to be the topic for further testing.

Calibration

"*Needs calibration: some "soft" notes, pianíssimo notes may noy recorded, because they were played and recorded in a midi system that response, but disklavier no. Others over react, they are not so loud. It´s both objective and subjective subject*."

As a Disklavier rendering is not entirety true to the original performance, due to various input methods and keyboards users employ, differing in response, some notes, (generally subtle) are omitted while others are very loudly accented. This combined with limitations in the MIDI protocol; the piano needs to be calibrated for each performance, to minimize these effects of these shortcomings.

Chapter 7

Critical Assessment

In the light of the data we clearly see what out of parameters such as venue, audience, joint concert and technologies has the most appeal. Being part of a joint concert with fellow musicians, together with having works of music played for a local audience somewhere in the world ranks high. This seems to prove, not necessarily that PT addresses these needs in the most adequate manner, but that the needs for being part of a concert, "contributing to a bigger musical picture" with fellow composers and also connect with a real audience somewhere in the world are deeply rooted, and central to our positive experiences of music praxis.

Following we saw that the unique sonic properties of a venue carries appeal, same as having ones music recorded and shared on the internet. Venues in this sense carries a unique acoustic fingerprint, and to have ones final artwork (the recording) "co-authored" with a remote space is a form of collaboration between man an inanimate objects is understandably fascinating. The fact that users in turn want to share these compositions with the world, just shows the social nature of art where we bring "*the most intimate and personal aspects of our being into the circle of social"* (Vygotsky, 1971).

Less appeal however had the Disklavier as the only means for musical output together with the fact that asynchronicity allowed for the creation of superiorly complex compositions, compared to live performance. This comes as somewhat as a surprise due to the fact of the inaccessibility of the technologies offered and the unique affordances of asynchronousity. At the bottom of the scale however we found both "listening to other composers recorded music" and the collectively creative act

of sampling, appropriating or “using someone else’s recording to create new works of musical art”. This might not be very surprising as we today are flooded with recorded music from everywhere, there’s really no shortage, and due to its accessibility the incentive to actually listen to a fellow composers recording is small. The same goes for appropriating piano music, which stands little chance compared to all other forms of music and sound-worlds available over networks today.

When it comes to the descriptive adjectives, we found that the most chosen were all positive, including “Approachable” that came a bit as a surprise however can be seen as a victory for the *visceral* or first-impression design of the value proposition of Perfect Take that obviously was straightforward and easy to understand, maybe compared to many more ambiguous technologies in NIME.

Chapter 8

Conclusion and Future Work

Computers and attendant networks have transformed not only the way humans make new sounds, but also interact with the timbre, pitch and tempo variations to produce what we call music. Furthermore, music, as a culturally embedded practice by which we bring the most intimate and personal aspects of our being into the circle of social, has been profoundly impacted by the augmentation of the time and space in this new context. The discourse by which we collectively engage in music culture through an ongoing perpetual exchange of sounds, styles, musical ideas and forms, has changed the process by which we bring about that which we in society label creative.

This dissertation therefore addressed this new context brought by this new computer-networked infrastructure of music[41], and how to best design NIME's on this infrastructure that will reward users, not only with trouble-free interaction but also a rewarding user experience. For this end we have employed *experience* design, as a complement to *interaction* design in the making of a prototype providing group music action. We base our prototype on needs defined from pianists in piano duets, some of which were of a socio-emotional nature, through which we investigated how the role the *venue*, *audience*, *joint concert* and *technologies* impact the user experience of this system. By doing so we have gained valuable some knowledge toward the understanding of the processes, services, events or environments in which NIME's

[41] Networked Music, any collaborative music activity in the context of computer mediated communication.

operate, a many times neglected part of the design of these, and further elaborate on the role these parameters might have in the adoption of NIME's among musicians.

8.1 Summary of contribution

The research carried out over the last three years departs from a basic understanding of an area of research that has come to be called CSCW for music applications or Networked Music and the contributions this thesis does is in several different areas.

8.1.1 Reciprocity in group music action

This thesis together with previous publications (Makelberge, Rethinking collaboration in networked music, 2012) situates various modes of group music making in Networked Music according to reciprocity or interdependence among involved users, and thus deepens our knowledge about group-dynamics in this field of research. A deeper understanding that ultimately provides technologies that address users needs and goals to a greater extent.

8.1.2 Creativity in Networked Music

This thesis together with a book chapter (Makelberge, Designing tools to support music creativity, 2012) makes an theoretical contribution to how the Networked Music infrastructure of computers and attendant networks supports creativity as it is understood in creativity research to date. This contribution is important as it allows designers of Networked Music applications to provide users with the circumstances that support creative musical output.

8.1.3 Introducing experience design to NIME.

This research, together with previous publications (Makelberge, Barbosa, Perrotta, & Ferreira, 2012) (Makelberge, 2010) investigates the paradigm of experience design in NIME and provides an example how to go about this by deriving needs and goals from existing forms of the behaviour we are designing for, in our case socio-emotional needs of group activities in music. By understanding group creation in the past, in our example in piano duets, we may be better at supporting it in the future, as in our new contexts of computers and worldwide networks.

8.1.4 Investigating contextual parameters

As no musical instrument exists in a vacuum but is culturally embedded in venues and audience, idioms, attendant technologies, even mass media and practices etc., this thesis together with previous research (Makelberge, Barbosa, Perrotta, & Ferreira, 2012) (Cordeiro & Makelberge, 2010) investigates the role and appeal of some of these contextual parameters such *venue, audience, joint concert* and *technologies* when it comes to the adoption of a new technology.

8.2 Future Work

Future work is from both practical and theoretical perspective. The practical involves that of improving the user experience of PT for administrators, musicians and audience. For administrators, this most urgently involves building a self-sustained system that needs minimal time and effort to maintain. For musicians this includes incorporating more functionality defined in the design mock-up, which didn't make it into the first prototype such as be provided biographical information about fellow composers, edit and delete their submissions etc. Other functionality that might be of

interest to musicians includes recording video, or streaming from the concert venue such as to provide users with visual feedback. Even analysis through eyesweb[42] concerning activity at the installation during a concert has interesting possibilities to explore. For the audience, improving the user experience includes providing the concert program with biographical information (as defined in the requirements and design mock-up).

More testing will also naturally help discovering more limitations of PT the way it is devised at the moment, but also reveal areas of opportunity that can be developed by further research. When it comes to experience design as a methodology in NIME, an interesting prospect for future work is to devise design patterns for these contextual parameters of NIME's we've defined through our research, however, how and in what form these will take will require time and thought.

When it comes to theoretical contributions, an area that is ripe for exploring further is creativity research within collaborative music practices and how the infrastructure of CSCW for music applications support this elusive phenomenon as defined in creativity and psychology research. Such research would add valuable insight into the social nature of creativity and how it appears in musical culture, and will bring not only insight to creativity in music, but also to creativity in general.

[42] http://www.infomus.org/eyesweb_eng.php

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Glossary

Acronyms

ACM – Association for computing machinery

AIFF – Audio Interchangeable File Format

ALSA - Advanced Linux Sound Architecture

API – Application Programming Interface

ARPANET - Advanced Research Projects Agency Network

CC – Creative Commons

CCRMA – Center for Computer Research in Misc and Acoustics

CITAR – Research Center for Science and Technology of the Arts

CSCW – Computer Supported Cooperative Work

DA – Discourse Analysis

DAW – Digital Audio Workstation

DJ – Disc Jockey

EDAL – Ensemble Delay Acceptance Limit

ESMAE - Escola Superior de Música e Artes do Espectáculo

EQ – Ergonomic Quality

FMOL - Faust Music On Line

HCI – Human Computer Interaction

HQ – Hedonic Quality

ICMC – International Computer Music Conference

ICT – Information and Communication Technologies

IMN – Interconnected Music Networks

KPI – Key performance indicators

LAN – Local Area Network

LEMUR - League of Electronic Musical Urban Robots

LED – Light emitting diod

L.H.O.O.Q. - Elle a chaud au cul

MIDI – Music Instrument Digital Interface

MIT – Massachusetts Institute of Technology

NIME – New Interfaces for Music Expression

PC – Personal Computer

PD – Pure Data

PSO – Public Sound Objects

PT – Perfect Take

SMC – Sound and Music Computing

UCD – User Centered Design

USB – Universal Serial Bus

VRS – Virtual Recording Studio

VST – Virtual Studio Technology

WAN – Wide Access Network

APPENDIX A

Published Work by the Author

Publications by Author

Papers in Peer-Reviewed Journals

Makelberge, N. (2012). Rethinking collaboration in networked music. *Organised Sound* , 28 – 35.

This paper argues that today's sampling culture, emerging out of pioneering efforts in electroacoustic music in the 1950s carries a similar ethos of autonomy found in many significant advances in music instrumentation throughout history. By looking at the evolution of musical instruments, the author hopes to address these continuous effort towards autonomy, which, if proves legitimate should be of great concern for networked music research that deals with all forms of music praxis of varying reciprocity and group dynamics. By further looking into what sets collaboration apart from cooperation and collective creation, and elaborating on the "social" of music, this paper hopes to extend the discourse on current trends of accessing, shaping and sharing music in solitude, from something often seen as unfortunate and anti-social, to something less so.

Joaquim, V. Guerreio, R, Makelberge, N. (2010) Sound and Music Conference 2009. CITAR Journal.

A Casa da Música, its opening initially scheduled to coincide with the year of "Cultural Capital of Europe 2001", first opened its doors on April 2005 slightly behind schedule. The buildings extraordinary display of modern architectural triumph joyously hosted the 6th SMC - Sound and Music Computing Conference, after

previously being hosted by Paris, Salerno, Marseille, Lefkada and Berlin. SMC 2009 was organized by the Institute for Systems and Computer Engineering of Porto (INESC Porto), the Research Center for Science and Technology in Art (CITAR) of the Universidade Católica Portuguesa in Porto, the School of Music and Performing Arts (ESMAE), Porto's Concert Hall: the Casa da Música, and the Department of Electrical and Computer Engineering of the Faculty of Engineering of the University of Porto. According to the organization, the SMC 2009 hosted two hundred participants from more than 50 countries, ranging from Hamilton, New Zealand to San Francisco, US, while the conference website received 22.500 hits from 110 countries across the world since its inception. Six events of the conference where transmited via www.casadamusica.tv, and was followed online in 35 countries.

Papers in Peer-Reviewed Conferences

Makelberge, N., Barbosa, A., Perrotta, A., & Ferreira, L. (2012). Perfect Take, experience design and new interfaces for musical expression. *Proceedings from the 12th international conference on new interfaces of musical expression (NIME2012).* Ann-Arbor: ACM SIGCHI.

"Perfect Take" is a public installation out of networked acoustic instruments that let composers from all over the world exhibit their MIDI-works by means of the Internet. The primary aim of this system is to offer composers a way to have works exhibited and recorded in venues and with technologies not accessible to him/her under normal circumstances. The Secondary aim of this research is to highlight experience design as a complement to interaction design, and a shift of focus from functionality of

a specific gestural controller, towards the environments, events and processes that they are part of.

Makelberge, N. (2010) Le Concert C'est Moi. *Proceedings of the 1st DESIRE Network Conference on Creativity and Innovation in Design / Desire Network* Lancaster, UK, UK ©2010.

In this paper I elaborate on the common notion of "collaboration" within music. I do so by contrasting what it constituted historically in the context of the piano, to that of some new interfaces of musical expression (NIME) collaborative in particular. By doing so I hope to shine light on the success (or lack there of) of many of these projects – and ultimately discuss some other realities of academia that might play an determinant role in these musical instruments success "beyond the lab".

Cordeiro, J. Makelberge, N. (2010) Hurly-Burly: An Experimental Framework for Sound Based Social Networking. *Proceedings of the 16th International Conference on Auditory Display (ICAD2010)*, Washington, D.C.

This project deals with the topic of social interrelations; its aim is to achieve a deeper understanding of the underlying mechanisms of these relations through the use of sound and mobile devices/ubiquitous computing. The proposed framework follows two interdependent directions: 1) using environmental sounds as input data for context analysis, 2) using sound as an output to express results (sonification). This project is part of a long-term research project concerning sound based social networks, conducted at the Research Centre for Science and Technology in Arts (CITAR). The aim of this paper is to share some initial results, both practical and conceptual in form of a related work overview on social networking technologies, a

conceptual design for a Facebook application based on the project initial idea (including an IPhone graphic interface proposal) and last but not least, an experimental framework for data communication between an IPhone and a computer (using Pure Data through RjDj).

Book Chapters

Makelberge, N. Designing Tools to Support Collaborative Music Creativity. *In Creativity in Design: understanding, capturing, supporting*. (eds.) Ball, L. Christensen, B. Martens, J.B. Mota, J. Dix, A. and Sas, C. Lancaster 2012.

Designing a tool for collaborative music *creation* is one thing, while designing for *creativity* is a whole other. In this chapter we will focus on the latter, and start off by looking at how factors that support creativity, such as the sounds we use, how we assemble them into music and communicate our musical ideas in time and space have changed by means of the computer and networking technology. We will then go into specific practices that utilize this new environment to its fullest, bringing forth works that are both novel and useful – or considered creative, to ultimately investigate what kind of socio-emotional, or hedonic (Hassenzahl, 2003) drivers are behind *why* we want to collaborate, or be creative with other people. These three taken together, the *what* of creative music, *how* to make creative music, and *why* we make creative music with others are the cornerstones to inform the design of tools to support collaborative music *creativity*. This approach is chosen as an attempt to go beyond interaction design and functionality and usability to a more *experience*-design approach of new interfaces of musical expression (NIME) that encompasses the emotion and needs of users.

APPENDIX B

Data of User Comments

Question: What do you find lacking (limitations/drawbacks) in the PT scenario?

1.

“I believe art does not begin in technology. Art begins from a human individual. From its roots, culture, believes, historical eras and most of all through the experience of a human in the world in constant search for the meaning of his existence. Disklavier lacks therefore, the whole artistic presence of a human artist and the mastery and infinite nuances of sound production. A true concert piano, I mean those made with utmost care and years of handmade work such as a prewar Steinway!, has a billion times more sensitivity towards sound production than any of nowadays most expensive pianos. That mainly influences texture, phrasing, pedaling, inner-voicing...etc. At Steinway Hall in NYC, there was a trial to imitate Rachmaninoff's performance of his Liebesleid through a Disklavier. I have never seen such a scientific failure! By all means, it was indeed a serious artistic accident! Regarding composing, true genius does not need any sort of technology to be able to compose! Beethoven, although deaf, had the capacity to hear the vibrations of his music deeper than anybody has ever had. He certainly did not need to play his music to hear how it sounds. There is a metaphysical hearing that great composers must develop in order to transcend!”

2.

“No video, or other feedback”

3.

“Multi-instrument play.”

4.

“It would be nice to expand the possibilities beyond the piano sound, maybe adding speakers for reproducing audio tracks and other electroacoustic instruments.”

5.

“Needs calibration: some "soft" notes, pianíssimo notes may noy recorded, because they were played and recorded in a midi system that response, but disklavier no. Others over react, they are not so loud. It´s both objective and subjective subject. Record is a different subject than share in internet. I might interest in record for some reason but not interested in share.”

6.

“sound limitations”

7.

“Musicality, sensitivity”

8.

“The only issue is accuracy in transmission. If it works perfectly well, fantastic. But advanced technology is sometimes rife with bugs and glitches; hopefully this will work out alright!”

9.

“Standard of the piano tuning should be very strict to allow precise playback.”

Question: What other functionality would you like to see in our system?

1.

“Way for user to follow concert”

2.

“Multi instrument play, including percussion and other GM sounds.”

3.

“It would be nice to expand the possibilities beyond the piano sound, maybe adding speakers for reproducing audio tracks and other electroacoustic instruments.”

4.

“1st draft Final recording.”

5.

“ability to orchestrate or add instruments”

6.

“Video and holograms”

7.

“Maybe it would be interesting to have voting system for audience”

8.

“I am not sure the word functionality is a word that I would use in the world of Arts. However, I believe the fidelity of Disklavier is currently rather poor in comparison to the real sound production of a performance. Of course that depends on how masterful and skillful the actual performer is and the challenge between both!”

Question: Suggestions for improvement when it comes to recording?

1.

“No feeling man”

2.

“Multi instrument MIDI”

3.

“be able to add minor room effects (reverb)”

4.

“have information about the disklavier response to certain MIDI values (to know the constraints of the instrument... how will my piece sound when playing notes with values of 20, 30, 100, etc...).”

5.

“You must calibrate better the system (loud and soft rapid notes. - A preview (limited) and final recording”

6.

“Need to hear all parts”

7.

“Details and sensitivity”

8.

“Keabord (mechanism) of the piano should be very equal and calibrated.”

9.

“At least the pedaling that a performer used should be correctly recorded!!! I am in general an open person to contemporary ideas, however, if any of us is concerned with the future of Art and its ethics, Disklavier is certainly like playing Dr. Frankenstein in Mary Shelley's book. Let us be responsible for our technological creations, care for the little art that is left in the world and stop playing Disklavier or Ipads in concert halls!!! The only thing it does is support and bring more artistic ignorance to the masses!”