Consuming Music Together

Social and Collaborative Aspects of Music Consumption Technologies

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Chapter 13

INTERACTION, EXPERIENCE AND THE FUTURE OF MUSIC

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1. INTRODUCTION

Digital personal music systems today offer conveniences where listeners can carry their whole music collections with them at all times. However this has come at a price where the richness of musical experience is compromised, leaving only remnants of a living, vibrating, dynamic musical past. Music has always pushed the envelope of what defines interaction. The systems described here create deep human interaction facilitated by live musical dynamics deployed on networks, sensors, and portable digital technologies.

This chapter introduces a vision for evolving definitions of music encouraging a return to it as a living form of cultural expression. The challenge put forth is how this goal can be attained for future end-user digital music systems. The arrival of new infrastructures for music rendering and distribution has the potential to change modes of music appreciation. Social interaction has already evolved with the advent of decentralized, peer-to-peer systems. The argument is that application of social computing coupled with artistic creativity can combine to point out ways in which technological evolution can be assimilated directly in cultural production, ultimately leading to possible new forms of musical content.

The problem is broached in two parts. First, I present projects from the fields of sound and media arts as examples of the assimilation of these concepts in contemporary artistic practice. In particular, the notion of *idiomatic* writing, borrowed from instrumental compositional technique, is used to describe innate musical capabilities of interactive technologies. Second, I retrace how notions of *interaction*, *agency*, and *experience* form the theoretical underpinnings guiding the conception of these works. In particular, I call upon cultural theory to situate this musical vision within a wider societal and historical context.

Even before the advent of digital technology, instrumental music provided compelling examples of the use of mechanical technology for cultural ends. Through processes of instrument making, composition, and performance, composers and musicians have built established channels for cultural transmission. We can link directly to each of these steps in cultural production as inspiration for reconsidering technical acts of system building, programming, and execution. In this way, we thwart the onus of economic value chains, proposing social alternatives whereby human imagination is paramount. In this way digital music is freed from banal questions of rights management, and instead becomes a catalyst for creating meaning for the listener.

Experiments in musical tele-presence that challenge notions of locality are called upon to inform the design of end-user network music systems. Technical problems of network transmission delay are confronted from musical points of view to create music specific to network media. In doing so, it is crucial to preserve the sense of agency of a participant. This ultimately leads to the possibility of establishing musical identity of an individual within a community of listeners.

An understanding of artistic and compositional practice sheds light on the musical potential of interactive technologies. Composition implies *authoring* and conception of new forms and *formats*. The compositional perspective can be extended beyond musical media to serve as a valuable point of view from which to consider humanistic use of digital technology. This text seeks to draw a line connecting artistic practice and research to propose novel concepts for possible future musics. Whether it subscribes to tenets of efficient design, or whether it holds commercial potential is not the criteria on which this thinking is based. Instead, the goal is to understand, guided by musical and cultural theory, the potential for new technology mediated musical experience.

2. ARTISTIC PRACTICE

2.1 The Instrument

The term musical instrument has a clear connotation across many cultures. An instrument is imagined to be a known physical apparatus that allows human performers to express themselves artistically through sound. Musical instruments in the traditional sense are assumed to be acoustic, constructed of wood, metal, and other materials, having resonant qualities. Sound is articulated when the user intervenes and excites vibrational modes. Music is made through skilful manipulation of the instrument, resulting in melody, harmony, and rich sonic timbre. There has been remarkably little questioning as musical instruments have embraced digital technology. Synthesizers often mimic the traditional piano keyboard layout, maintaining the assumption of manual articulation. Meanwhile the reprogrammable software nature of digital instruments adds a layer of generality or “virtualness”. Instead of considering the possible extension of the definition of a musical *instrument*, these digital music devices are often also referred to as *tools*. Traditional

acoustic instruments are never confused with tools. Why then do the expanded expressive powers of digital instruments banish them to be considered utilitarian? Perhaps it is the generality and chameleon-like qualities of digital musical instruments. Or could it be that our cultural associations with instruments are trapped in the mechanical era and hinder us from imagining the expressive potential of these new instruments? If we are to see how the instrumental perspective may lead to conception of new consumer music formats, it maybe helpful to review the distinction between "instrument" and "tool".

A musical instrument becomes an expressive object in the hands of a performer, and is a vehicle in an engaging concert performance. This gives the instrument a distinguishing characteristic when compared to a simple tool. The term tool implies that an apparatus takes on a specific task, utilitarian in nature, carried out in an efficient manner. A tool can be improved to be more efficient, can take on new features to help in realizing its task, and can even take on other, new tasks not part of the original design specification. In the ideal case, a tool expands the limits of what it can do. It should be easy to use, and be accessible to wide range of naive users. Limitations or defaults are seen as aspects that can be improved upon.

A musical instrument's *raison-d'etre*, on the other hand, is not at all utilitarian. It is not meant to carry out a single well defined task in the way that a tool is. Instead, a musical instrument often changes context, withstanding changes of musical style played on it while maintaining its identity. A tool gets better as it attains perfection in realizing its tasks. The evolution of an instrument is less driven by practical concerns, and is motivated instead by the quality of sound the instrument produces. In this regard, it is not so necessary for an instrument to be perfect as much as it is important for it to display distinguishing characteristics, or "personality". What might be considered imperfections or limitations from the perspective of tool design often contribute to a "voice" of a musical instrument.

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.

An input device is the gateway through which the user accesses the computer functionality. As a generalist device, input devices like the keyboard or mouse allow the manipulation of a variety of different software tools. Music software endow the computer with specific sonic capabilities. Special input devices can be built to exploit these particular capabilities. On what begins life as a generalized platform, we begin to build specialized musical systems, each component – input device, signal processing algorithm, audio output module – becoming part of the total instrument description.

The goal is not to find fault with technological systems, but to observe a difference of purpose. The goal of creating an efficient software tool differs fundamentally from that of creating an expressive musical instrument. The definitions distinguishing *tools* from *instruments* in the physical real also apply in software. As music has increasingly become deployed on digital technologies, the question arises: is the digitization of music driven by a desire for optimization and

convenience, or is there a creative potential inherent and particular to digital technology that can be harnessed and heard in the resulting music? If this is true, then what can we do to transform a generalized *tool-like* technology into an expressive *instrument-like* medium? Does the generality inherent in digital technology represent the democratization of the creative process, or is it okay to conceive of music software with steep learning curves if the pay off is a kind of virtuosity?

2.2 The Idiomatic in Digital

A conservatory curriculum in composition systematically includes a study of *instrumentation*, or *orchestration*. This includes not only the knowledge of combinations of instrumental sounds that create rich arrangements, but is a detailed understanding of each instrument, its workings, and character (Berlioz, 1991).

When a composer finds what an instrument is capable of expressing, he is finding its *voice*. The term *idiomatic* is used to describe this characteristic of an instrument. To give an example, the violin and flute are two instruments that share a nearly identical note range, from low note to high note. Although they may be able to play melodies in a similar *tessitura*, each instrument has its own distinct character. This is predicated on the mechanical and acoustical make up of the instrument – a violin being a stringed instrument while the flute a woodwind instrument. This differentiates not just articulatory modes producing sound, but also musical qualities such as polyphony or typical melodic intervals. These elements all contribute to distinguish idiomatic violin music from idiomatic flute music.

Digital synthesizers and samplers are sophisticated enough today to mimic the sounds of orchestral instruments. But no matter how faithful a timbre a synthesizer may attain, if the mode of articulation remains a generalized piano keyboard interface, the uniquely idiomatic *violin-ness* or *flute-ness* of a melody are lost. This is not purely the fault of digital representations – traditional musical notation in itself has no capability of transmitting *idiomaticity* of an instrument. It is the composer who ultimately holds responsibility for "knowing" each instrument to write music that respects the character of that instrument. We will see below how this notion of idiomaticity can be directly applied to digital content authoring to create compelling experiences specifically for digital media.

I claim that digital technologies have a *voice* in the way that traditional instruments do. Whereas in the case of digital instruments, these may be processes running on general purpose computers, each interactive system brings with it a personality of its own. Here I present an artist's project where this thinking was applied directoy to new instrument design and performance.

2.3 Sensor Instruments

Sensorband is a trio ensemble that has performed internationally in the experimental music and media arts scenes since 1993. The three musicians, Edwin van der Heide, Zbigniew Karkorwski, and the present author, perform on

instruments made of gesture sensing interfaces. Van de Heide plays hand-worn devices resembling virtual reality gloves, where multiple ultrasound transmitter/receivers detect the relative orientation and distance between the two hands. Karkowski plays inside a scaffolding structure armed with infrared beam arrays detecting spatial percussive gestures, their speed and direction. Tanaka's instrument is his own body, where arm muscle tension is sensed by electromyogram (EMG) electrodes translating neuronal muscle activity to digital musical control data.

The three instruments in the Sensorband instrumentarium all allow free space gestures of the musician to be captured via a sensor system to articulate digitally synthesized sound on the computer. Each instrument, however, has its distinct mode of operation, be it ultrasound, infrared, or biosignal sensing. The similarities and differences among the instruments result in a musical identity that consistent with the above discussion of idiomaticity. The similarities of the instruments, the fact that they are sensor-based gesture instruments, make them members of a single instrument family. Much in the way that traditional instruments constitute families such as the stringed, woodwind, brass, and percussion instrument families, these three technological instruments together comprise the family of *sensor instruments*.

At the same time, the distinctiveness of each instrument within the instrument family creates a diversity and richness. A flute and oboe are both members of the woodwind family, and even share a similar melodic range. But the flute is a non-reed instrument while the oboe is a double-reed, setting acoustical waves by the excitation and mutual vibration of two wooden slivers while the flute creates acoustical jets across a hole. This defines each instrument's characteristic timbre and expressivity. While they share similar articulation, by breath, they differ in their tone, rapidity, and dynamic. Each instrument in this way, as members of a common family, takes on their own specific musical identity.

These sensor instruments are indeed members of the same instrument family, with each exhibiting a uniqueness of voice, each one distinguishing itself from the others by mode of operation and aptness for articulating specific types of sounds. The infrared cage of Karkowski has the clearest idiomatic identity – infrared beams are interrupted by swift gestures causing impulses to be sent to the computer. The sensing of directionality and velocity as well as the dense sensor array make this deceptively simple interface more complex than it may first seem. This instrument is ultimately to a palette of percussive sounds. Compared to the impact nature of the infrared instrument, the ultrasound and biosignal instruments are more apt to sculpting longer continuous sounds. Each, however, has its defining characteristic. The ultrasound sensors have a stability and precision, and their layout on the gloves create an orthogonality for rapid switching and holding. The biosignal, while also apt for continuous data sculpting, presents a living signal to the computer. The performer cannot hold a single value constant, and makes continuous effort to maintain a level. This physicality is reflected in the jittery data transmitted to the sound synthesis modules.

These articulative modes of the three sensor instruments define their character and ultimately the music that is idiomatic to each (Tanaka, 2000). It is by composing music for the ensemble all while respecting the idiomaticity of each constituent

instrument that a music identifiable as that of Sensorband arises. Beyond the musical identity of a group, the idiomatic writing becomes a key to listener comprehension of layers and parts within the music. Listeners empirically use instrumental identity to decode and understand music. Even in the absence of formal musical education, most lay people have an idea of the sound that a certain instrument makes – the sound of a trumpet compared the sound of a violin as distinguished from the sound of a drum. While the human auditory perception system has sophisticated physiological mechanisms in place to parse complex audio streams (Bregman, 1994), this cognitive parsing is a key to higher level musical appreciation (Deutsch, 1998). This game of musical association tied to instrumental identity aids the listener in comprehending a polyphonic musical stream to decipher the melodies, parts, and motifs that make up the musical whole.

With electronic sounds, listeners lose the grounding they had with the familiarity of acoustic instruments. The very power of sound synthesis to create new, never heard before sounds has the equal potential to disoriente the listener. While electronic music in its various flavours is ostensibly the exploration of uncharted territories, the position put forth here is that idiomatic writing can help to re-establish a sense of listener comprehension of these new forms. The sound of Sensorband, at first, is a wall of electronic sound. To the untrained ear, it could be created by three people or it could be created by one single person, or it could be completely dehumanized and machine generated. Quickly, however, the listener senses the human agency in the music as corporeal gesture manifests itself in sound. This invites the listener to try to unravel the puzzle while solos and turn taking introduce each of the instruments more clearly. With these associative keys in place, the listener becomes able to continue to decode the music when ensemble play resumes. The linear melodies and lines are those of van der Heide's ultrasound measures. The swelling beds that come and go in waves is Tanaka's muscular gesture. The intense percussive strikes are Karkowski striking in thin air through invisible infrared beams. If the performance were to stop here, it would be suspiciously similar to a straightforward technology demonstration, showing the wonders and workings of various interfaces. But far from a demonstration, a concert must exploit these keys of comprehension to first pull the listener in, and then modulate the nature of the relationships between instruments. At times ultra-clear, at times distorting idiomatic sense to create total confusion, a Sensorband concert becomes a drama of corporeality mapped to technology, leading the audience through alternating clarity and mystery.

2.4 Network Music

I next present a series of network music projects – music and sound art works realized on the Internet. I include them here as a way to demonstrate the use of idiomatic writing, applied not to objects such as instruments, but to communications infrastructures. This section first presents network performances, followed by public space installations, works for web browsers, and finally hybrid pieces (Tanaka, 2004a).

There is a history of music performance practice on networks (Gresham-

Lancaster, 1998). One of the central themes of interest has been about perturbations of musical communication. Remote performance configurations are created to conduct investigations of the musical effects of network data transmission. This meant setting up video conferencing systems where we could send audio and video from a camera onstage in one city to another stage in another city, to organize a performance connecting the two cities with musicians at the remote sites in live musical interaction. Such concerts were organized over a period of ten years, from 1995, connecting Paris and New York, Barcelona and Rotterdam, Budapest and Montreal, and Tokyo with Paris.

One of the claims of the Information Age is that the modes of communication made possible by the Internet can collapse geographical distance. In attempting to carry out this promise, one quickly confronts the reality of time delays and quality losses as musical data is transmitted over the net. I did not wish to hide these realities but instead highlight them as qualities to be considered in the musical process.

The first challenge was to find a way to maintain eye-to-eye contact over the videoconferencing system The single stage of a traditional concert had been extended by a pair of video cameras and video projectors. Part of the challenge was to maintain a compelling performance dynamic for the local audience while keeping musical contact with the remote performer. As there were audiences on both sides, the remote performer had the same responsibility at his site. Once communication established, the musicians' concerns shifted to the quality of communication – for example, the trade off between picture pixelization, fluidity of motion, and time latency

There is forcibly a time delay inherent in network data transmission. In playing network concerts, the first concern of participating musicians is the *latency*, or time delay, of the system. The data-compression algorithms and data transmission times resulted in delays ranging from 0.5 seconds to 30 seconds or more in older systems. Given this kind of situation, a traditional musician could not expect to perform music as if he is was normally accustomed to. "But the timing is strange," the musician might say, "how can we play our music this way, it's not going to work." My reply always was that the musician could not expect to impose *his* music unaltered onto a new time/space domain. The technology, contrary to what is often advertised, is not transparent. While the typical reaction of a musician was to ask if the technology could be improved to eliminate latency, my response as composer was not to re-program network algorithms, but to write music for the given situation. To me it was somehow appropriate that any given music could not simply be transplanted and successfully performed on a network infrastructure.

If networks had significant latency for real time applications, to me it meant that the network had a specific temporal characteristic. Seen in this light, it was the same as when composers consider the acoustical characteristic of a concert space in which their work might be performed. Composers of sacred music in the Medieval era were writing for reverberant cathedral architectures. They were fully aware of this, even taking advantage of the long reverberation times to "hide" secular melodies within the long, slowly moving lines of the *cantus firmus* (Grout and Palisca, 2000). Be-bop jazz musicians meanwhile responded to the intimacy and short reverberation

time of jazz clubs to play blazingly fast solos. Playing a be-bop solo in a cathedral would just smear the rapid melody, make little musical sense.

I wanted to extend this instinct enabling musicans to respect the acoustics of physical spaces and apply it to the time latency of network spaces. Music exists in space, in acoustical contexts, in the environments that it is played in. If music is made on networks, the network infrastructure becomes the space the music occupies. The time characteristic of that infrastructure defines the musical quality of that medium. Network transmission latency thus becomes the *acoustic of the network*, to be respected and exploited, just as one does when composing for specific physical spaces (Tanaka, 2003).

2.5 From Time to Space

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. If time is not the strength of the network, then, I wondered if the other axis of the time-space domain might hold more promise. I began an investigation of the musical qualities of spatial dimension of the Internet. For this, I created works that were not concert pieces, but rather gallery and web-site based installations.

Constellations is a gallery installation, premiered at the Coexistencias design festival in 1999 in Lisbon Portugal. The aim was to juxtapose the physical space of an art gallery with the so-called *virtual* space of the Internet. Five computers were set up in a gallery space, each connected to the Internet and each with its own speaker system. Software running on each machine presented an abstract graphical interface of spheres (like planets in a constellation). Gallery visitors were able to click on planets to invoke the streaming of MP3 sound files from the Internet. The visitor could click on more than one planet, thus streaming multiple sounds. In this way, the software was fundamentally different than the CD player-like interface typical of MP3 player software, limited to listening to one piece of music at a time. The visitor could mix the multiple streams of music by gliding through the constellations space – closer planets would have their sounds stronger in the mix than streams of planets further in the graphical interface. Each of the five computers in the gallery, then, could create its own mix of sounds from the Internet. And as the speakers of each of the computers played out into the physical space of the gallery, there was also a spatial, acoustical mix taking place of all the five computers' individual mixes heard together.

These two levels of sound mixing – Internet mixing and acoustic mixing, constitute the dynamic at the core of the piece. The goal was to sonify, or represent in sound, the multitude parallelism of data flow on the network. It seemed to me that this did not differ so much from the simultaneity of aural stimuli in which we live in everyday life. By superimposing audio mixes of these two environments, I sought to situate the listener in network space and acoustical space at once.

While Constellations juxtaposed mixing of multiple network MP3 streams alongside acoustic mixing of multiple sources in the gallery space, *MP3q* (2000) did away with physical space, but added a participative element by the possibility of

user upload. MP3q is a web browser based piece. The listener mixes multiple music streams using an abstract graphical text interface, and also could contribute his own sounds. Driven by participation, the piece was at its outset but an empty shell. MP3q is an open piece, a participative system where contributions from listeners became the base musical materials of the piece. In fact this was where, for me, as a composer, I was starting to try to let go of total control, asking myself if I could make a musical piece without making the music itself, but by composing with the social dynamic of the Internet, to create situations that exploited web surfing behavior to musical ends. In that sense it was a composition with no original sound, a *content-less composition*.

The questioning, from the artist's point of view, was about his continuing pertinence in an open system (Tanaka, 2001). How does the role of the artist change, what is the job of the artist? Does he retain authorship when the piece is an open form? My answer is 'yes'; it is definitely still my piece even if it is music and even if I have made no sound; I am the composer of the piece because I have created the system, I have created it as an environment where people must figure out how to react. This is completely different from a generalized user interface. The "interface" of MP3q is not optimized for ease of use or for productivity. It is instead an idiosyncratic artifact, a situation created by the artist that incites or naturally filters certain reactions. I am, as the composer, gently guiding or deviating the user or pulling him through my way of seeing things and inviting them to send in a piece of sound that becomes part of the piece. In that way it is my piece because I have created that instantaneous dramaturgy that drives usage and the kinds of sounds, ultimately, that would be uploaded.

By creating a participative dynamic, I wanted to explore the supposed democratic quality of the Internet. The first question that arose was, if I made a completely open work, would I be able to rightly claim title to be composer of the work? How could I reconcile the hierarchical status of the composer with the democratic nature of the medium? The converse to these two questions were: If I made an open form, how could I assure that it would not become random and meaningless? If I was to put my name on the piece, how could I justify it as being a product of my creativity, and how could I guarantee its quality? While today, we begin to have rights licensing models, such at the Creative Commons, that permit appropriation and re-sampling, my interest was to look at the actual musical impact of such culture.

This musical questioning in these participative works were the to application of ideas from post-modern thought, where the artist's role was no longer one to create an *object*, but rather to create a *situation* (Levy, 2000). By orchestrating participative channels, I created natural filters without imposing commands on the users. The dynamic of interaction provoking reaction allowed the contributor to speak freely, but in response to a proposition that was relevant to the composition, and ultimately instigated by the composer.

2.6 Hybrids: Physicality and Virtuality

The next type of work presented is one where I try to bring together the work

with sensor instruments and the work with networks. One example of this is a piece called *Global String*, created in collaboration with the composer and electric bassist, Kasper Toeplitz. The idea was to make a musical string like a guitar string, but of monumental proportions. The "string" is a steel cable, 16mm diameter, 15 meters long. Although this seems big already, it's only part of the string as the concept was to use the network to make an instrument that connects two cities.

On each cable are a series of sensors detecting vibration, as well as an actuator capable of inducing impulses in the string. Actions on one end of the string would be picked up by the sensor subsystem and transmitted over the network connection to the other end. Striking the string in one city would cause the endpoint in the opposite city to vibrate. Remote players could play in a collaborative fashion on physical interfaces that conceptually constitute a single instrument, a monochord spanning two distant locations.

The use of sensors in conjunction with networks allowed me to make physical action the musical information transmitted on the network. By building a single "string", it was a use of the network not as a medium to collapse distance, but a resonant medium to span distance. While the endpoints are massive cables, the body of the string is the Internet. It is a musical instrument made up of parts, very physical on its two ends but very invisible and immaterial and ultimately just data in the middle. There is the mixture of the virtual and the real; the network acts as its resonating body, with network traffic conditions tuning parameters affecting the sound. This maps network processes into a physical experience (Shedroff, 2001).

It was to an instrument, not just destined for concert performance, but also to occupy public space as an installation. Museum visitors could approach it, touch it, hit it, make some sound and maybe find someone on the other end. It thus responds to naive use, drawing the visitor in to explore further. At the same time it is a performance instrument on which a pair of virtuoso performers can and do give concerts. These performers know intimately the intricacies of the instrument, it's responsiveness, its various articulatory modes. The goal was to make a single musical instrument that could adapt to different levels of playing. Like on a piano, if a young child comes to and bangs on the instrument, he can make noise and have fun, but if a virtuoso sits down to play on the very same instrument, he can make incredible music. The instrument has not changed – it has a depth that makes it accomadate these different levels of use. I was interested to see if we could bring that same sort of musical depth to digital technology. In video games there is typically a setting for user levels where the software can be tuned to respond accordingly to beginner or advanced players. There are no "levels" in musical instruments – it is a constant that should be rich and deep enough to react and respond in an organic way to varying levels of play (Tanaka and Bongers, 2001).

3. THE MUSIC OF SOCIAL DYNAMICS

The recurring theme in these projects was the search for musical qualities of the network, to create work that is *idiomatic* for the medium. It seemed to me that *downloadable* music was anachronistic and tells only half the story in a medium that

was by nature bidirectional. What was the *voice* of *uploadable* music? While a musician's instinct might be to try to exert his mastery and ego on a situation, finding the musical voice idiomatic to a democratic medium also meant learning to let go. Rather than controlling time and space with sound, I seek to create architectures for collective musical processes.

The fact that my artistic projects led me to the logical conclusion to embrace the openness of networks, I developed a vision that idiomaticity in network music would be borne out through social dynamic. This would lay the groundwork for a musical research project I carried out on wireless netowork infrastructures. In this project, mobile systems are used to support compositional structures allowing groups of people to participate in the musical creation process. Subconscious acts while listening to music and moving around urban environments are stimuli to the system. *Musical avatars* represent geographic location and shared co-experience create a *social remix*.

I sought to bring the questioning of continuing pertinence of the artist to its extreme endpoint, and see if we could simply take the artist out of the system. Although we will see that the artist retains a crucial position in the content authoring process, I wanted to leave the user or a community of users to create the musical dynamic at rendering time. The interest was to see if we could create musical experiences by and among non-musicians that nonetheless called upon the tenets of interactivity established in the art pieces described here.

With this in mind I created a system where mobile musical devices were in social communication over wireless networks. These musical objects did not resemble musical instruments as much as they did personal music listening devices. They were however endowed with advanced capabilities borrowed from the sensor instrument and network music projects, including the ability to receive a continuous stream of dynamically generated music, an upload channel permitting a context aware information to be sent up, and a sensor sub-system capable of capturing user gestures.

The project is called *Malleable Mobile Music*: "mobile" like a cellular telephone, "music" because it's about organized sound, and "malleable" meaning something that's plastic, that can be shaped like clay. It is a concept for a consumer music system where music can be played, and be played with. Deployed on mobile systems and taking urban dynamic and listener gestures as input, the system places communities of listeners together in a shared musical experience.

Each device in the system is equipped with sensors that measure the pressure of user grip on the device as well as gross device movement and rotation, sensing gestures such as swinging the device along in rhythm to the music (Tanaka, 2004b; Tanaka, 2004c).

Music delivery is a generative service running on the network on the *Malleable Music Engine*. It receives sensor input from clients on the network and generates a musical stream. The musical output can be shaped, its structures manipulated, in response to incoming data from the clients. Modules that make up a musical piece include rhythms, fragments of sequences, and samples. Time domain re-sequencing of elements is applied at multiple musical levels. The low level re-sequencing allows user actions to intuitively create variations in rhythm and melody. High level re-

ordering allows song structure to be *malleable*, to match the corresponding social activity that drives the progress of the music. These techniques are applied to standard popular songs and assume a constant meter and tempo. The system is context aware, but above all sensitive to the human state. Existing music is rendered interactive by the system, giving listeners new ways to listen to familiar music.

What do I mean by shared experience or co-experience? The idea is to take urban mobility and make it a system where people can listen to music together and have a music that is sensitive to social dynamic. People could be far away, remote, as we were in network music projects, but participating in a collective act. They have a common activity where active listening is an input to the system. Their implication in the evolution of a single piece of music turns this common activity into common purpose. Listening to a Walkman is no loner a passive, isolated activity, but a participative social activity. Geographic location, user's grip holding the device, their swinging along to rhythm, all contribute to creating a communal *social remix*.

4. FROM INTERACTION TO EXPERIENCE

4.1 Music and Interaction

Music played on digital systems implies some level of interaction with the "user" or listener. As digital music is most commonly practiced on computers, it should benefit from techniques from human-computer interaction research. The richness and complexity of music, however, make it a challenging application area for HCI. It is argued that music, be it digital or acoustic, independent of technology, is inherently interactive. Interaction patterns observed in music could in fact inform technology design. Music is a cultural practice that has the potential ultimately to contribute to a deeper understanding of interaction.

Here I briefly retrace the history of interaction design practice, and draw parallels to musical practice. Early work on human-machine interaction was inspired by seminal work in social interaction by Goffman. Goffman introduces the notion of *line* and *face*, line being patterns of acts by an individual in light of social situations, and face being the external social value of that individual (Goffman, 1967). We are familiar with the notion of face in the social concept of "losing face." These social rites create the basis of human-human interaction in what Goffman calls an *expressive order*.

This expressive order is taken up in early formulations of human-machine interaction. Norman applies this directly to his *decision cycle model*, a seven step model defining the interaction between user and system (Norman, 1986). The steps consist of:

goal formation
translation to intention
translation to commands

execution
perception of state
interpretation
evaluation against original expectations
reformulation of goals, restart loop

This model in its simple form is better suited to describe pragmatic aspects of interfaces such as windows, buttons, and menus, than to describe creative processes such as music. The basic decision cycle loop has been expanded upon in more recent work allowing for more spontaneous modes of interaction (Kirsh, 1997). This work begins to draw upon the social nature of Goffman's original work, extending human-computer interaction research to embrace humanistic values such as engagement and sociability. This leads to improvisation, progression, interruptability, mutuality, and turn taking (Rafaeli and Sudweeks, 1997), concepts which are all directly pertinent to music making. A successful interaction dynamic gives rise to jointly produced meaning, or the creation of shared interpretive contexts. This ties directly to musical ensemble performance as well as transmission of meaning in a musical performance.

Music is interactive because there are multiple dimensions of dynamic relations. There is a relationship between the musician and his instrument, a bi-directional exchange of give and take. When a musician plays a violin, this violin is a dynamical system, and organic entity, with which the artist is in a relationship. The violin gives as much back to the performer as the player puts in in energy and verve. There is also interaction between musicians. If a group is on stage there is a live, human interaction between musicians. And, finally, there is interaction between the performer and the audience. There must be some kind of relationship set up, a communication or perhaps a dis-communication, some kind of dynamic that goes out but also feeds back. It is in such a situation of appreciation or controversy when a performance is deemed interesting. These are all examples of interactivity that are not in the domain of the digital, but are more than simply social. Instrumental music, then, already establish rich forms of human-"machine" interaction that catalyze human-human interaction. The artistic work I have presented here seeks to bring this organic depth into the digital domain, assimilating musical instrument interaction to extend the potential of human-computer interaction. The Malleable Mobile Music system then draws upon social interaction as observed in peer-to-peer networks applied to more than simple file sharing to create rich musical experiences.

4.2 Agency

Digital music systems will forever be compared with acoustic musical instruments. Guardians of tradition claim that acoustical instruments have a richness and expressivity that cold digital devices do not. By extending the notions of idiomatic writing from existing instruments to new media, I sought to take a hard look at the digital instrument, seeking out qualities that endow it with musical depth. In the discussion of interaction, I define the richness of the dynamics created in the user-instrument system. I turn now to look at the user, to see what are the needs to

elicit satisfaction from a digital music system. We continue our tactic of looking towards traditional instrument practice for inspiration. The satisfaction of a musician lies in the sense he has of his own actions in the resulting music. This can be the responsiveness of an instrument turning subtleties of articulation into expression. It is also the identifiability a musician maintains in feeling the contribution his part is making in an ensemble. I call these notions a *sense of musical agency*.

Agency can be defined as an ability to take actions, to have initiative. The notion of *agency* appears in the fields of complexity and artificial intelligence as well as in moral and cultural studies. While related, the scientific and cultural views towards this concept fundamentally differ. We would assume that music, being a cultural activity, would tend towards the latter viewpoint. However, music as a cultural form albeit with technical basis in acoustic and mathematics, has always drawn upon science. Digital music underscores this technical link, and serves as an area rich in potential for establishing a middle ground, or superposition, of the scientific and the cultural. With this in mind, I attempt to develop here this double view on the term *agency* to demonstrate their relevance in the conception of the artistic works presented above.

In the realm of computer science, agents, or autonomous hardware or software processes, can be categorized as having weak agency or strong agency. Weak agency (Woolridge and Jennings, 1995) is characterized by traits of:

autonomy
reactivity
pro-activity
communicativeness

Strong agency builds upon weak agency by adding elements of intentionality (Dennett, 1997), including traits such as:

knowledge
belief
choice
obligation

Despite the seemingly epistemic qualities ascribed to strong agents, this is a strictly cognitive viewpoint where agents simply seek survival and not reason. While this approach may one day lead to an understanding of meaning making, they are far from characterizing the elusive magic of artistic creativity. The terminology, however, may be useful in grounding otherwise intuitive and subjective human activity.

Moral philosophical approaches to agency are observed in Greek antiquity by Williams (1993). Agency also plays an important part in the Enlightenment philosophy of Kant (1998) where sense of duty and universality leads to notions of responsibility that places a subject in his environment.

In post-modern thought, Lyotard defines *grands récits* as the master narratives of society (Lyotard, 1984). This is akin to the collective conscience, forming the

environment in which an individual exists. In contrast, *petits récits* are the personal narratives of an individual agent, describing its unique history. Personal narrative colors an agent's interpretation of the master narrative. From this point of view, free will is fundamental, empowering in the agent acts of self-construction (Bruner, 1990). Agency becomes at times a rebellious act to re-shaping an agent's place within the master narrative, thereby building identity (Bamberg and Andrews, 2004).

How do we integrate these notions of agency into music, in particular potential musics arising from digital technologies? In the present context, the intentionality of agency can be embodied in the traditional acts of composition and performance. Though accountability could be considered elements for sense of obligation to give a good performance, or to transmit good (or deviant) messages through stage presence and lyrics, they are beyond the scope of this text. Agency that gives rise to musical identity, on the other hand, is a core concern to be discussed here. The negotiation between master narrative and personal narrative allow music heard by groups of people to shape the personal identity of individual listeners, at times leading to feedback where the behaviour of a fan-base could drive marketing efforts ultimately affecting output of the artist of the originating music. If the listener becomes more implicated in the musical creative process, bypassing the influence of traditional marketing channels, agency can be directly linked to musical creation. Much in the way that a musician in an ensemble assumes agency for his part, a participative listener needs the satisfaction, consciously or subconsciously, to have a sense of his own agency in a collective musical process. In order for the user to fulfill these social needs, the components of a system must facilitate agency. In a digital music system, this means that individual elements can take on characteristics of strong agency to respond to human need and desire (Håkansson et al., 2005). In Social Computing the term *translucence* is used to describe the use of social information to support collective action (Erickson and Kellogg, 2000). Here I apply these concepts to music, and extend them to distinguish *reflexive translucence*, where an agent is endowed with a sense of his actions within the collective whole. Ultimately, a dynamic interactive music system will exhibit technical agency providing musical means for channeling humanistic agency of an individual within his listener community.

In practical terms, this comes back to the responsiveness of an instrument, and the identifiability of an instrumental voice within an ensemble context. With a digital instrument, these challenges become a question of system design. A sensor system needs to be *reactive* to the gestures of the user. The *mapping* from sensor input to sound synthesis must maintain a simplicity and directness at the same time it needs to have complexity and richness. A network music system inevitably exhibits *latency* (transmission delay), within which a local user's actions need to be identifiable.

4.3 Shared Experience

The sum of instrumental idiomaticity, of user-instrument interaction, and user's sense of agency together contribute to the total *musical experience.* A musical

experience can range from the simple happenstance of hearing a new piece of music all the way to a life changing moment where a piece of music becomes a personal revelation. Experience is the term often associated with the magic of music. Seen in this light, experience is an intangible and undescribable concept. However, throughout history, philosophers have attempted to characterize experience, and more recently the design and marketing fields have attempted to exploit experience. I attempt here to synthesize these views of experience to situate musical experience as I have developed it in my artistic and research work.

The word experience has recently received a lot of attention, attaining buzz-word status. It has even been appropriated by the marketing industry as an economic model (Pine and Gilmore, 1999). The desire to understand the mechanisms to provide compelling experiences to end users has become a preoccupation of the design field (Shedroff, 2001). While these are sources often cited, the true roots of experience run much deeper. Are these models of experience satisfactory to desribe the magic of music?

What was experience before being co-opted by Madison Avenue? In the Enlightenment era, Rousseau called upon inner experience as a guiding light in lifelong learning (Rousseau, 1755). Romantic era Hermaneutics thinkers defined experience as a for building meaning (Dilthey, 1996). Experience is defined to be personal and self-referential, and implies that an individual can be proactive in shaping its own destiny. Transmission of experience takes place through expression and interpretation which in turn create new experiences (Turner and Bruner, 1986).

Transmission of experience has traditionally been focused on verbal expression. With the increasingly media-centric society, visual imagery has become the predominant medium for propagating experiences (Baudrillard, 1979). This has led to a situation where culture and commerce compete for the public's attention in an over-saturated media space. Sound, on the other hand, has been relatively unexploited to this end. The projects I have presented here attempt to create unique experiential situations through the power of sound. An understanding of experience from this perspective could lend a richer more profound understanding than a design or economically motivated exploitation of the term.

Even if sound as a medium has been less exploited than image for generating experience in the industrial sense of the term, music is a cultural form has always drawn upon personal experience. Experience feeds the inspiration that motivates creators of music. In a well known example, J.S. Bach was so moved by ear opening sounds of a contemporary master, Buxtehude, to have traveled over a hundred kilometers by foot in order to hear his music. While Buxtehude is recognized by scholars, he is a minor figure in the public eye. However, this moment in the musical awakening of one of history's great composers has been referred to as the *Buxtehude Experience* (Wolff, 2001).

In popular music, songs such as Jimmy Hendrix's *Are You Experienced?* allude to mind opening experiences. Here music became a vehicle to represent and communicate the flower power of the 60's in challenging social mores, and of psychedelic drugs as the catalyst to personal revelation. In the contemporary era the link of musical experience to underground music culture continues, with the stylistic evolution of the techno movement shaped on the template of an extended

psychedelic experience (Reynolds, 1999).

As in the case of agency and translucence, my work attempts to situate the individual musically in collective action. The notions of personal narrative and master narrative can be applied to experience to distinguish private experience from shared experience. Techniques in cognitive science such as joint attention can lead to shared experience. In my work, I seek to create *shared musical experience* empirically through collective action. I extend notions of ensemble performance, democratizing the privelage of group musical participation without placing technical demands on the users. I tap into personal experience of each listener, coupled with networked group dynamic, to generate collective musical output that can be considered experiential.

5. FULFILLING CULTURAL THEORY

While the concepts underlying the projects described here came out of thought and purpose, they can be viewed through the lens of post-modern thought. The sociological effects of music are well described, here in this book and elsewhere, by cultural theorists. As sociological texts they look at the effect of existing music on society. With my stance of a composer, I am interested in the inverse, that is to say the effect of society on music. I am interested to see in what ways music as a form could directly respond to streams of cultural thought. I am interested in the effect that ideas from post-modernism could have not just as a way to analyze music's impact on human behavior, but as a way to drive the evolution of music so as to reflect current cultural conditions. If successful, this line of thinking has the potential to inform the design of music systems and new content formats to have a direct relevance to contemporary society.

I draw upon the writings of Baudrillard, Attali, and Levy to formulate my culture-to-music mappings. I briefly describe here the parts of their discourse that are pertinent to my musician's point of view, and then demonstrate how the projects described here bear out their ideas in real musical situations.

Baudrillard retraces turning points in socio-economic history, deriving a view of the displacement of *value* in society (Baudrillard, 1995). In the 19th century pre-industrial era, value in society was generated in the *original* object, typically hand crafted. Uniqueness held ultimate value. By the end of the 19th century, with the advent of the Industrial Revolution, came the means of mass production, the capability to make unlimited copies of an original. Value then shifted to the *reproduction*, or the capacity of replication. Today in the post-industrial era, technological advances have obviated the original-mould-copy sequence. Using computer-aided design (CAD) processes, it has become possible to generate a design that is fabricated with no original template as basis. Value has shifted to the *model*, the conception of an object in virtual form.

This displacement of value can be directly mapped onto the evolution of music. Before the industrial revolution, the transmission of music was through live performance. Before the radio and the phonograph, people's enjoyment of music came through playing music in its *original* sense. Children of good families would

learn how to play the piano for enjoyment of the family in the salon (McCutcheon, 2001). With the industrial revolution came the tape-recorder and the phonograph, allowing the mechanical reproduction of music (Benjamin, 1969). Musical value passed from the original to the *reproduction* and the infrastructures of distribution. This is borne out by the importance of the Billboard charts tracking the number of copies sold of a hit record.

Following this logic, today in the Information Society, with peer-to-peer sharing of MP3 files, reproduction has moved beyond the mechanical – it is now just a trivial case of data replication. We no longer have the need for the physical artefacts of recorded media, be they vinyl or compact disc, they have lost all apparent value as carriers of music. What then could correspond to the *model* in Baudrillard's chain?

One possible answer comes to light in Attali's *Noise*, where he retraces a similar path, but directly related to the history of music (Attali, 1985). Attali reaches further back in history than Baudrillard, ascribing a *sacrificial* function to the original experience of music. Organisations like the church eventually formalized sacrifice in the mediated rites of church services. The second phase for Attali is *représentation*, catalyzed by the invention of the printing press in the 15th century through the formalization of copyright in 18th century France. Music could be represented on a separate medium, allowing its transportation across time and space for deferred execution. The French term *représentation*, however, differs in nuance from the English in its connotation of a performative element. In French, the word is literally re-*presentation*, the reenactment of a performative act. In this way, *représentation* is Attali's musical equivalent for Baudrillard's *original*, with the rights infrastructures to support and defend the original musical act. *Répétition* follows, lining up with Baudrillard's *reproduction*. Repetition in the form of recordings differs from representation in that it obviates the need for the original performer. Music is thus commodified, having lost its ritualistic power, and becomes a product for mass production and consumption.

Finally Attali concludes by predicting a forth phase, that of *composition*. Again the word is employed in the French sense where it does not connote the act of the composer. Instead, for Attali, composition is the state where,

"Production melds with consumption…invested in the act of doing. It becomes a starting point rather than being an end product…"

My interpretation of this phrase, from a musician's point of view, is that Attali is alluding to future potential musical forms that are not finished works, but instead generated at the time of listening. Taken together, Baudrillard's *model* and Attali's *composition* begin to define incipient content formats that correspond to the information driven society we currently inhabit. I sought to test the real-world viability of these claims by integrating them into the conception of the projects I have presented here. The art pieces and end-user prototypes described conceive of a music that is constructed not as a deterministic product, but as structures of possibility, to be completed only at render time with the active participation of the listener.

6. CONCLUSIONS

The work discussed here spans the worlds of art and research. They are however motivated by a single vision of music as a dynamic, living form. The presentation of the work includes description of finished work, followed by terminology for design criteria, finishing with theoretical justifications. This at first glance may seem like a complete inversion of the hypothesis-theory-proof sequence of scientific method. I chose to present my work in this way because ultimately music must stand on its own, independent of any explanation. At the same time, the artist has a responsibility to society, and must maintain relevance for his work to have impact. In this way, artistic production is not a whimsical or capricious act, but a reflection on the contemporary condition. The music and musical projects I propose are not a proofs of theory, but are the result of conceptual reflection.

After all theoretical and conceptual considerations, music must move its creator and its listeners. The ultimate criteria is one of *satisfaction*, be it intellectual, emotional, or physical. The discussion of interaction, agency, and translucence, map out the means by which musical satisfaction might be attained. Music poses a unique challenge in the application of design principles in that efficiency is not necessarily the final solution. Musical instruments are expressive artefacts far from utilitarian in nature. Optimization does not necessarily allow an instrument to become more articulate. Instead, an understanding of of a medium and a respect for its character through idiomatic writing allow the voice of an instrument to speak.

It is this view of musical expression that brings us to a conception of music that can have social relevance. Artistic expression is not the sole prerogative of the artist. His responsability is to see what can be expressed through musical mediums. By making an instrument speak, the artist sets in motion a dynamic of transmission and sharing. Seen in this light, interactive systems and networks are technologies that exhibit this expressive, instrumental potential. The creative process is completed when the listener enters the loop. It is only then that expression takes place, as the sum total of the satisfaction lived out by artist, instrument, and listener. I do not seek to confuse these roles, but to create rhizomes of participative exchange. It is in doing so that shared musical experience can be created.

This text attempts to create a vision for future music by grounding these ideas in real world projects. The art projects presented redefine traditional hierarchical presentation structures. The research prototype described extends this to leverage social roles for musical creation. In this way I hope to pull up end-user expectations about engagement in the musical process. However, I am not asking the listener to become composer or musician. This was a harsh lesson learned in the 90's in the heyday of CD-ROM multimedia – ultimately the consumer does not have a pressing need to become sole creator of a work. We can, however, take notice of other cultures, where music permeates life to the point where participation is a given and where Western European notions of who is a creator and who is a spectator do not apply. I envision scenarios where digital technologies empower the layperson to inhabit musical spaces that are sensitive to them and representative of their social situations.

Artists display an intuitive sense for creative appropriation of new technologies.

The arrival of the radio, and of recorded formats such as the 45rpm vinyl, 33rpm, and compact disc, have given rise to new musical formats such as the rock 'n roll single and the concept album (Tanaka, 2005). Deployment of music over networks should be no exception. Why then has this creative potential been supplanted by legalistic battles on profiteering of music as commodity? This is ironic especially in view of the fact that digital technology is mean to democratize the power of creativity. If this is indeed true, then we must identify mechanisms by which this creative potential can be harnessed. In the case of music, I believe that this requires a re-examination of existing musical form and content formats. I have argued that it is instructive to apply instrumental notions of idiomaticity to the otherwise utilitarian conceptions of computers. This leads us to create systems that open up, and give the listener a sense of participation in, the musical creation process. We bring music back to its origins as a dynamic cultural medium, and by doing so re-invent music.

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