

## **TELEMATIC MUSIC: SIX PERSPECTIVES**

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### **ABSTRACT**

The Telematic Music Panel was formed as a result of a concert the panelists performed together on November 16, 2007. Telematic music is defined as music performed live and simultaneously across geographic location via the internet. The concert took place simultaneously at Rensselaer Polytechnic Institute in Troy, New York, Stanford University in Stanford, California, and University of California San Diego. The audio software used was JackTrip developed by Chris Chafe at Stanford, and video software was iCHATav. The Telematic Music Panel gives context and description for the music that took place November 16, 2007. This panel was presented December 16, 2007, at the International Society for Improvised Music Conference at Northwestern University in Evanston, Illinois.

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## PAPERS

### **From Telephone to High Speed Internet: A Brief History of My Tele-Musical Performances**

**Pauline Oliveros**

**December 14, 2007**

Why would anyone care to perform music between distant locations? If you are on the East Coast and the musician you want to perform with is on the West Coast then there is a reason. If it is possible to do such a thing then there is more reason. As the technology improves exponentially and ubiquitously then eventually there will be no reason not to perform music at a distance. Globalization gives us more reason. Making music together makes friends.

*Stuart Dempster and I celebrated 50 years of musical friendship in 2005\* with an audience at Mills College in Oakland, CA. Dempster was performing from DXArts at the University of Washington in Seattle, WA, and I from iEAR Studios at Rensselaer Polytechnic Institute in Troy, NY. Our images appeared side by side on the large screen in the Mills College Concert Hall. There were two dancers with choreography by June Watanabe on stage improvising with us in real space. Occasionally their images were projected on screen as well joining the virtual (but live) space inter-play of our networked improvisation. Remarks from the audience underscored how “intimate” this performance seemed to be even though we were not physically there.*

Tele-transmissions have been attempted successfully since the 1860s leading to the adoption of the telephone in all its variations and models from the hand cranked to the cell phones in use today. Before such technologies communicating sound over distance has been important to humans (and animals) for all kinds of purposes.

Animals sound loudly seeking to warn others of predators, birds sound out their territory, resonator pillows helped to warn sleeping Chinese armies of approaching attacks from others, whistling is a form of distance communication in the Alps and other mountainous regions, talking drums converse in Africa and many other analog varieties of distance communications exist.

The telephone has been developed and refined primarily for voice communication. Transmitting music over phone lines is subject to compression and equalization that degrades musical sound quality. The signal is confined to a narrow bandwidth that favors voice frequencies and the suppression of high and low frequency noise. Nevertheless musicians can and do play over telephone lines and more recently over the INTERNET now with CD quality audio in multiple channels.

My first large-scale music transmission was a six-city celebration of 40 Years of Composing in November 1991. A video telephone bridge was organized by Joe Catalano<sup>1</sup> of Oakland, CA, to connect Kingston, NY; New York, NY; Houston, TX; San Diego, CA; Los Angeles, CA; and Oakland, CA. I invited my friends to perform whatever they would like in order to help me celebrate this marker in my composing career. There was a 20-minute broadcast from each city. For the finale there was a six-city improvisation. Since the telephone line would grab the loudest signal the improvisation was based on sensitivity to give and take. Video was still image updated every 5 seconds. This latency had advantage for surprising changes in sequences of images.

Picture-Tel 4000 over ISDN phone lines was the next technology. Video was moving image with a slight delay that looked rather impressionistic with pixel trails following large motions. The audio quality was improved. Deep Listening Band performed *Through the Distance* (1996), together as a distributed trio with David Gamper at the Kitchen in New York, myself at Northwestern University in Evanston, IL, and Stuart Dempster at the Speakeasy Café in Seattle, WA.<sup>2</sup> Each of us had two screens that showed the other two members of our trio with our live presence. There were three audiences as well.

Internet transmissions became possible in the late 1990s with an 8-second latency. The Rocking Horse Trio with Maggi Payne, flute, and Brenda Hutchinson, long tube, and me performed *Loose Ends/Connections*<sup>3</sup> with Helen Thorington, Jesse Gilbert, Zeena Parkins, Scott Rosenberg and others transmitting audio from two locations to a third location that mixed the audio and streamed it over the Web. The 8-second latency became a structural element of the improvisation.

In 2005 iCHATav for MacIntosh computer afforded many fruitful improvisations with distant partners. Latency depended on bandwidth and traffic but often was around 1/2 second with video a bit more delayed. I performed *40 Days and 40 Nights*<sup>4</sup> — an accordion duet with sound track composed by True Rosaschi with Raimondas Sviackevicius at the 2005 Jauna Muzika Festival in Vilnius, Lithuania — to an enthusiastic, sold-out house.

Together with Scot Gresham-Lancaster<sup>5</sup> we performed *AB\_Time*<sup>6</sup> a three-way transmission with dancers and musicians at Mills College in Oakland, CA; Skalen Dance Company Studio in Marseille, FR; and iEAR Studio in Troy, NY. All could see and hear one another. Patrick Laffonte, video artist arranged projections in Marseille so that the audience sometimes experienced the live dancers on screen with the distant performers creating illusions that were disorienting as to place and time opening a vast potential for the art of virtual space.

In 2006 with my colleague Jonas Braasch from Sonic Architecture at RPI we initiated

weekly transmissions with Chris Chafe, director of CCRMA at Stanford University. For the first time we experienced low latency CD quality audio transmission and began a long term improvisation collaboration using JackTrip<sup>7</sup> — open source software developed by Chris Chafe.

In the summer of 2007 we added from McGill University Jeremy Cooperstock's Ultra-Video conferencing software for DV quality video.<sup>8</sup> We presented our work at the International Conference on Audio Display (ICAD)<sup>9</sup> in June at McGill University in Montreal with ensemble members at RPI in Troy, NY; KAIC Institute in Seoul, Korea; and CCRMA Stanford University in Palo Alto, CA. Video treatments by visual artist Bart Woodstrup were added for this performance.

In August 2007 we presented our work at the SIGGRAPH<sup>10</sup> international conference at the CalIT Auditorium, University of California in San Diego.

The most recent transmission involved UCSD, CCRMA and IEAR on Nov 16, 2007, in a concert prepared with a total of 44 musicians participating in a three-site improvisation guided with sound painting by Sarah Weaver and Mark Dresser.<sup>11</sup>

So the question asked at the beginning of this paper “Why would anyone care to perform music between distant locations?” has larger implications. After 18 years of engagement with telematic music performance I look forward to the continued evolution of the medium. It is heartening to think that I can connect with my many friends throughout the world and strengthen our relationship with global culture. The ability to link with partners around the globe with less and less latency is an exciting development to say the least. Musicians are leading the way to global development with a conscious way of connecting non-violently.

### End Notes

- 1) Stuart Dempster: “Sedimental Journey by Chris Stover,” *ITA Journal* **34**, Issue 2 (Spring/April 2006).
- 2) Joe Catalano, “Electronic Midwifery: A Videophone Celebration of Pauline Oliveros's "Four Decades of Composing and Community,"” *Leonardo Music Journal*, Vol. 3 (1993), pp. 29-34
- 3) David Gamper, Pauline Oliveros, “A Performer-Controlled Live Sound-Processing System: New Developments and Implementations of the Expanded Instrument System,” *Leonardo Music Journal*, Vol. 8, *Ghosts and Monsters: Technology and Personality in Contemporary Music* (1998), pp. 33-38

- 4) <http://turbulence.org/archives/98.html>  
Feedback with 7 Musicians and interactive Graphics  
Various Artists: *Loose Ends/Connections* and *Feedback*  
<http://www.turbulence.org/Works/loose/index.html>  
<http://www.turbulence.org/Works/feed/index.html>
  - 5) 40 Days and 40 Nights by True Rosaschi  
[http://www.youtube.com/watch?v=2qBI9Pdk\\_D4](http://www.youtube.com/watch?v=2qBI9Pdk_D4)  
<http://www.musicaveritas.com/music/performance/index.html>
  - 6) <http://www.skalen.fr/> Click Laboratories then AB\_Time  
<http://www.o-art.org/Scot/Chronology.html>
  - 7) <http://ccrma.stanford.edu/groups/soundwire/software/jacktrip/>
  - 8) <http://ultravideo.mcgill.edu/cgi-bin/script.pl>  
<http://ultravideo.mcgill.edu/>
  - 9) <http://www.music.mcgill.ca/icad2007/>  
[http://transition.turbulence.org/networked\\_music\\_review/2007/07/03/icad-2007-conference-on-auditory-display-proceedings/](http://transition.turbulence.org/networked_music_review/2007/07/03/icad-2007-conference-on-auditory-display-proceedings/)
  - 10) <http://www.siggraph.org/s2007/attendees/art/performance.html>
  - 11) <http://ccrma.stanford.edu/groups/soundwire/>
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## **Telematic Music Performance Practice: Sound Transcending Distance**

**Sarah Weaver**

### **Background**

My involvement in telematic music began in the fall of 2006. I had been studying the Deep Listening practice of composer Pauline Oliveros intensively since 2002 and took great interest in the discussions I heard of telematic music through my studies with Pauline. At the Deep Listening Retreat in summer of 2006 at Rose Mountain, NM, I approached Pauline about a telematic music collaborative project between her ensemble Tintinnabulate at Rensselaer Polytechnic Institute (RPI) in Troy, NY, and my professional ensemble Weave, located at that time in Chicago, IL. I have conducted

Weave for ten years using Soundpainting — a gestural language originated by composer Walter Thompson that indicates parameters for improvisation. The artistic vision of Weave has a fundamental relationship with the concepts of telematic music, so this project was a natural fit for the medium. We created a performance that took place October 25, 2006, at the Chicago Calling Festival curated by Dan Godston, and the iEAR Series at RPI.

The next telematic collaboration happened on March 22, 2007, between Weave in residence at Loyola University in Chicago, Tintinnabulate at RPI, SoundWIRE directed by Chris Chafe at the Center for Computer Research in Music and Acoustics (CCRMA) at Stanford University in California, and the Digital Arts New Media (DANM) ensemble at University of California Santa Cruz directed by Synthia Payne. The performance was titled *100 Meeting Places* after Pauline's piece on the program. It was during this project cycle that I decided to apply for the five-year Deep Listening apprenticeship program. I was accepted, and after my three years of living in Chicago I moved back to New York in June 2007 for the program.

The Deep Listening Convergence was a telematic residency for forty-five Deep Listening Artists January-June 2007. The Convergence culminated in a one-week in-person residency centered at Lifebridge Sanctuary in High Falls, NY, plus performances at the Sanctuary for Independent Media in Troy, NY, and Time and Space Limited in Hudson, NY. In September 2007 I began working as a visiting artist co-directing Tintinnabulate at RPI with Pauline, Jonas Braasch, and Curtis Bahn. This cycle resulted in the November 16, 2007, performance on which this Telematic Music Panel is based. The collaboration was between Tintinnabulate at RPI, SoundWIRE at Stanford University, and our newest member of the Telematic Circle — VistaMuse at the University of California San Diego directed by Mark Dresser, Adriene Jenik, Shahrokh Yadegari, and Victoria Petrovitch.

Mark Dresser immediately became a strong proponent for the development of work in this medium. As a prominent figure of the contemporary music field, Mark brought this level of artistry and passion to telematics, engaging in the development of the music, methodology, and exposure of telematics in professional and educational music spheres. As a collaborator I share a background with Mark in Soundpainting, and Mark was also a student of Pauline many years ago. This conjunction presented an opportunity for collaboration in telematics that integrated artistic language and orientation on new levels, inciting an atmosphere of amalgamative momentum within this project.

Telematic performances continued throughout the fall semester, with a piece titled *Dreamwaker* on October 19, 2007, between Weave and Edo Paulus' installation *Resonating-With secondlife Wind* in the online virtual reality world Second Life. The performance took place at Ione's 12th Annual Dream Festival in Kingston NY, with guest performers Pauline Oliveros (accordion), Ione (spoken word), and Mark Dresser

(bass). Concurrently as Executive Director of the International Society for Improvised Music (ISIM) I planned the annual conference taking place December 14-16, 2007, at Northwestern University in Evanston, IL titled *Building Bridges: Improvisation as a Unifying Agent in Education, Arts, and Society*. This conference included three telematic performances directed by Jonas Braasch, Doug Van Nort, and Pauline Oliveros, and presented the Telematic Music Panel.

The November 16, 2007, performance had a program of three pieces: *TeleCello Concerto* (RPI and Stanford), *Water Naught* (RPI and UCSD), and *Three Ways* (RPI, Stanford, UCSD). I directed Tintinnabulate at RPI for *TeleCello Concerto* and *Water Naught*. A discussion of these two pieces follows.

### **TeleCello Concerto**

#### **Description.**

The TeleCello Concerto was a piece that featured Chris Chafe on four-channel cello. Each of his four strings were assigned to a channel that sounded from four individual speakers within surround sound. Chris improvised the solo, and I used Soundpainting to conduct the ensemble accompaniment with Tintinnabulate at Rennselaer Polytechnic Institute and SoundWIRE at Stanford University simultaneously.

#### **Attention Modalities.**

I conceived of the two ensembles performing together as one group in a singular composite space. This required a shift in my own attention, and awareness of how my Soundpainting gestures would function in co-located space. Even though I was physically located at RPI, I had to be aware that each gesture would be received differently from each location. For example, certain gestures in Soundpainting designate individuals to play on cue if the location of the gesture is aligned with the player. If I use the gesture “point to point” locally, the musicians at RPI play when pointed to, and stop when I stop pointing. However the location of the same gesture as seen by Stanford, three thousand miles away on a video screen, is made in a general directional field, yet it is interpreted as if it is specifically signaled to the individual musicians. Therefore my choice of gesture and its creative result depended on my awareness of working in composite space.

#### **Audio and Video Delay.**

Another aspect of telematics in TeleCello Concerto was working with the inherent delay of the medium. We used JackTrip audio on Internet2 which has approximately  $\frac{1}{4}$  second delay, and iCHATav video which has approximately one-second delay. There were different artistic choices within this delay environment. When I first approached this piece I gradually shifted the textures to de-emphasize the delay. My next experiment purposefully utilized delay in creating shifts within the rhythmic structures. What was surprising about working in real time was that while some of the gestures created more

obvious delays between the ensembles, other gestures widened the experience of time. I experienced the ensembles playing together simultaneously as if the downbeat became wider. My experience of "time slowing down" relates to reports of certain kinds of trauma, or conversely of "time speeding up" as in the phrase, "time flies when you're having fun." My perception of time fluctuated in a tuning of time density within the piece. I was able to conduct the ensemble within this shared expansion and contraction of time.

### **Communication Technology.**

The audio and video software proved to be quite functional. Audio information was sent to two different surround sound systems in each location. The quality was good enough that the sensation of one ensemble playing together was palpable. This experience was more akin to playing together in a recording studio with isolation booths and headphone mixes. Even though the balance and mix between ensembles was less than perfect, I still could feel the vibrations of both ensembles well enough to perceive and transmit intuitive musical decisions.

For the video we had a split screen in both locations. At Stanford, one side of the screen showed Chris, and the other side roamed the Stanford ensemble. At RPI, one side of the screen was focused on me, and the other side roamed the RPI ensemble. The purpose of the video was to monitor what was happening, however it did create a sense of connection as well. I was able to see Chris well enough to read his body language and correlate it with his sound. The Stanford ensemble was also able to see my gestures clearly, and the roaming ensemble cameras assisted me in further correlating sound and body language. What the cameras were not able to capture was the true two-way visual communication that happens between a conductor and the ensemble in a local space. This did not prevent us from attaining an artistic expression of the music, but more can certainly be explored with camera and ensemble placement to further facilitate this communication.

### **Water Naught**

#### **Description.**

Water Naught was a Soundpainting piece between Rensselaer Polytechnic Institute and University of California San Diego. I conducted *Tintinnabulate* locally at RPI and Mark Dresser conducted *VistaMuse* locally at UCSD. We conducted our ensembles simultaneously. Mark designed the palette structure, asking students and faculty at both schools to collaborate and develop three minute palettes of composed material based on metaphor and the telematic space to be integrated into the piece.

#### **Attention Modalities.**

In this piece there were different modalities of attention available since both groups had a



local conductor. Since we had the two ensembles conducted simultaneously, the piece could be developed in tandem, but did not have to be developed always as one ensemble. This afforded a flexibility of attention which yielded more locally-specific content, bringing a richness of expression to the composite sound, while maintaining the collaborative evolution of the piece.

Development of attention between the two groups was also built into the piece through the palettes that were created across ensembles. In most cases the performers of the palettes were also the composers, so each palette was the result of a creation process that took place over several weeks within each palette subgroup. This process bridged a potential attention gap, bringing the performers closer together creatively and guaranteeing substantive collaborative interaction across the ensembles.

I took part in one of these palette subgroups on trombone, with Mark Dresser on bass, Pauline Oliveros on conch shells and percussion, Jefferson Pitcher on guitar, and Stephanie Loveless on voice. We began the piece with our palette, which meant both conductors started the piece by playing instruments instead of conducting. The shift of attention from performing to conducting was more of a musical shift than a shift of telematic attention since both modes required sustained connection of the space for our piece.

### **Audio and Video Delay.**

The same delay environment existed for *Water Naught* as we had for the *TeleCello Concerto*. The audio was delayed  $\frac{1}{4}$  second and the video was delayed one second. The factor of delay that most affected my choices was being able to see Mark conducting. This was a positive effect because Soundpainting most often involves a series of preparatory gestures before the initiation of the parameters, so I could see what was about to happen and make informed choices. This made my approach to Soundpainting significantly different than the *TeleCello Concerto*. At times I worked in real-time with my own choices, but being able to see Mark provided me with a chance to coordinate parameters and initiations in a way that I had not experienced before in local duo Soundpainting.

There was a different flow to navigating delay in this piece, beyond the aforementioned technical issues. Seeing Mark's preparatory Soundpainting gestures gave me the choice to coordinate with Mark or not. We could work independently or together either transcending the delay or using the delay as an aesthetic parameter. Within Soundpainting we could create layers of different kinds of delay: rhythmic, cyclic, and meaning levels.

Another major key to working with the delay was the palettes themselves. The palettes were designed to work within the properties of telematic space. Several different

approaches were taken, such as computer processing of sound, temporal shifting, and textures that purposely undulate with the delay.

These creative solutions, combined with the perceived expansion and contraction of telematic time cited in the *TeleCello Concerto*, resulted in a sophisticated time system that we were able to incorporate artistically into our approach to *Water Naught*.

### **Communication Technology.**

The audio and video communication technology discussed for *TeleCello Concerto* holds true for *Water Naught* as well. Unique to the *Water Naught* rehearsal process was that members of the ensembles used a variety of consumer-level live internet communication applications to prepare palettes and to develop every aspect of the piece. The software used for these purposes included Skype, iChat, iVisit, and several instant messaging programs.

Each software program presents idiosyncrasies for communicating telematically. Navigating the software requires development of skills in order to maximize communication. Communication can become heightened or compromised depending on factors such as use of audio, video, and/or chat, how many people are communicating together, the technical quality of the connection, and the interface of the software. Communications can become slower as multiple participants use up available bandwidth, our communication patterns and rhythms vary between sound and visual applications, and even the heightened possibility of a dropped connection can affect prioritization of information. Gaining experiences with the software gave more telematic communication skills to the performers. They could use this awareness to inform the development of their palettes and development as performers in the medium.

Mark Dresser and I began using telematic software in the beginning of this project to develop the piece and communicate about the planning for rehearsals, performance, and documentation. We purposefully used the software in order to locate as many aspects of the project as we could into the telematic medium. This also became a way to research telematic software and discover which applications were most conducive to our communications. We found our way into using a mixture of effective audio, video, and text applications, each with their own character, rhythm, and shaping of telematic space. In fact, it became an intuitive choice to make in deciding which mode to engage in for the communication needed at the time. Sometimes we even changed modes if the tone of our discussion could be better supported another way. Combinations of modes could vary as well. At times one of us would be on video and text, while the other was on text only. Often choice was also influenced by which technology was working best at the time, giving the sensation of the medium shaping our communication. Text chatting worked consistently and on rare occasion we would finish a conversation by cell phone. We always had access to sufficient communication technology, but on a deeper level we

stayed in constant refinement of choice and the will of communication modes to maximize our collaboration.

As Mark and I engaged in telematic communication for this project, the software became noticeably effective for this purpose. The telematic frontier was so rich with new artistic possibilities that were inspiring to both of us that we began to communicate telematically about telematics on a day-to-day basis. Almost exclusively through this communication across distance Mark and I were able to develop an intensive collaboration with presence that is on par with any local collaboration I have been involved with. In some ways I feel that communicating telematically took the effectiveness and depth of the collaboration far beyond what could have happened locally. This to me is indicative of the level of communication and artistry that can become possible for telematic music.

### **Process.**

The development process of the November 16, 2007, performance highlights the capacity for telematics to transcend geographic distance and create new meanings for artistic collaboration. Assisted by technology, but ultimately achieved through human vibratory connection, telematics presents a liminal space for collaboration that can propel music into uncharted depths afforded by the expanded potentials of joint location.

The process of creating, rehearsing, and performing these pieces was such a coalescence of the experience and deep potentials of the telematic medium that it became the impetus for my initiation of the Telematic Music Panel. In my previous year of telematic music projects I became familiar with the medium, the artistry and technology involved, some of the potentials for distance collaboration, and had emerging artistic experiences that piqued my interest and passion for the medium. This project, however, ignited an expansive and translucent experience of telematics that shed light on the properties of the medium, illuminating fundamental purpose and specific qualities of telematic music that sparked encounters of the art form itself at work.

I felt this occurred through harmony of joined location, the integration of compatible artistic languages, and openings of deep support and trust. This can perhaps be best illustrated by a rehearsal that happened during the fires of Southern California, October 22, 2007. The rehearsal was for a palette in *Water Naught*. Mark, Pauline, and I were in attendance telematically, while Jefferson was unable to be there due to his wife's pregnancy complications. Mark was on tour in the northeast, and the fires were in close range of his home and family in Encinitas, CA. Pauline had close ties to the region after living there for many years, and I had relatives living in San Diego. Pauline suggested we meditate together, so we did, via telematic technology. At this point in the project our joined space transformed, exposing and encompassing now the very roots of human connection, expressed through a crisis of life and death across geographic distance. This experience exemplified the intensity of connection that becomes possible through the

transformation of location. This distinctive capacity can be experienced and is imminent in the music, making telematics an important medium for artistic communication within our global society.

### **Conclusion**

The performance on November 16, 2007, was a representation of our creative relationship with the medium, encompassing our process and artistic collaboration, shaped by the expansion of our joined location. The developing technology and developing artistic medium provided an atmosphere of creating communications, which was reflected in the music of the performance and the momentum of the participants to continue exploring the medium. I look forward to engaging in the future of this profound artistic medium.

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## **Tele-Social Music Making**

**Mark Dresser**

### **Background**

My involvement in sustained telematic performance and collaboration began a year ago, in December 2006, when I proposed an interdisciplinary research group to be co-led with three colleagues at University of California-San Diego (UCSD); Adriene Jenik — a media artist in the visual arts department, Shahrokh Yadegari a sound designer/composer and Victoria Petrovich, a designer in the theater and dance department. My personal interest in telematic performance grew out of the pragmatic need to find an alternative way to perform, due to the worsening restrictions in travel with a double bass since 9/11. The promise of telematic performance, to transcend physical place, seemed a logical step with interesting social, environmental and potentially unique artistic possibilities.

Pauline Oliveros had told me about her coordination between the Tintinnabulate ensemble at Rensselaer Polytechnic Institute (RPI), and Chris Chafe's SoundWIRE ensemble at Stanford University. Both were very supportive of our getting set up with the JackTrip software, which Chris had authored. In early September, over dinner in Guelph, Ontario, Pauline patiently spelled out the process and procedure and generously shared RPI's technical, administrative, and artistic documents, which became the blueprint of how we at UCSD, would approach our intercampus collaboration, with support from The Center for Research in Computing in the Arts, (CRCA) at California Institute for Telecommunications and Information Technology,(Callt2). We had agreed that for the first five weeks, we'd hook up solely with RPI. We literally had one hour a week to work together and generally at least half of that time was struggling with the technical issues of

hearing and seeing image.

### **Water Naught**

Even before connecting with Tintinnabulate, I had considered using Walter Thompson's Soundpainting language as an interdisciplinary interface because of its versatility and my prior experience as a Soundpainting conductor. Since Sarah Weaver, an expert Soundpainter, was already Soundpainting the "TeleCello Concerto" between RPI and Stanford, it made total sense to use this common language for "Water Naught" between RPI and UCSD.

In Soundpainting, a "palette" is a category for any composed or preconceived event. As a class assignment, I requested that the two ensembles break down into smaller groups consisting of three to five people from both campuses and create six palettes based on metaphor, which I defined as a verbal descriptor of an image, phenomena, or concept. Each group was asked to generate a three-minute performable event from this idea. The only other requirement was that all rehearsals, communication, and brainstorming sessions be conducted on the internet.

Following Pauline's model for Tintinnabulate, we created a class Gmail account with shared password, and communicated using a combination of softwares including Google Calendar, iVisit, SKYPE, IChat, and as last resort, the phone. We posted our results on Google Documents for all to read and collectively edit and update. This process went on in stages for five weeks leading up to the performance. The range of our palettes and the interpretation were broad. Realizations of metaphors included "interference, tempo phasing, states of water from ice to vapor, pantomime, and the networked stage."

My group palette consisted of five members including Pauline on conch shells and harmonica, Sarah on trombone, Stephanie Loveless singing and text, Jefferson Pitcher on electric guitar and myself on bass. Our metaphor was to realize the 'changing states of water.' We had discussed this in terms of the ecological implications of global warming. Step by step we were evolving a plan to orchestrate this idea.

I'll never forget our rehearsal on October 22nd when this palette took on a personal dimension. Only Pauline Oliveros, Sarah Weaver and myself were free to meet that evening. After struggling on iVisit, we finally abandoned this software and connected on SKYPE each of us at different locations on the East Coast. I was speaking from my hotel room in Amherst, MA, having just driven five hours on a short East Coast tour. All day long I had been in hourly communication with my wife, as fires were raging in San Diego, as close as five miles from our home in Encinitas. Jefferson, was at the hospital with his wife, nervously monitoring her premature labor contractions. All of our intentions to work together were trumped by the reality of people we knew and cared about, potentially in harms way. Pauline, a former resident of San Diego, suggested that

we meditate on all of this, sending our vibes of concern, to our friends, family, and the unknown fate of our colleagues and class ensemble. For minutes we silently sat, still connected on SKYPE, each tuning-in on our own meditative levels. After a long while, I realized I was unable to concentrate on our work and broke the silence and excused myself from the rehearsal. Yet still, it was a profound bonding experience, perhaps a moment of telematic sanity. Through the telematic medium we connected on a much different level and in a real sense, with a sensibility greater than ourselves. Due to this new collective experience, our palette took on a personal significance; we ended up naming the piece “Water Naught.”

### **Three Ways**

“Three Ways” was conceived as a feature for the string trio of Chris Chafe — cello, (a four-channel midi cello) at Stanford, Curtis — Bahn-dilruba (an ancient Indian folk instrument with motion sensors on the bow to MaxMSP patches) at RPI, and myself on electro-acoustic bass at UCSD, with members of the total ensemble gradually joining in. Initially the idea was to have members of the total group to gradually join at their discretion. This proved to be unsatisfying due to the tendency for the density of thirty improvisers to accumulate quickly and stay at the same level. After studying a composite list of all of the participants and which instrument they played, I proposed nine different contrasting and cascading orchestrations; each consisting of four members, one from UCSD, one from RPI, and two from Stanford. There were also special features, for several of the main directors, including a sax feature for Jonas Braasch, an unaccompanied solo for Pauline on harmonica, and a feature for Curtis on dilruba with voices.

We had only had one rehearsal with Stanford’s SoundWIRE prior to the dress rehearsal, so I had little knowledge of the improvisational sensibilities of the members of SoundWIRE. I made choices based on orchestrations rather than any informed sense of improvisational potential. I cued each new grouping with a hand signal. The final orchestration included the entire ensemble; it became a moment of collective density, followed by a coda for Chris, Curtis and myself.

### **Evaluation**

On an artistic level, the November 16<sup>th</sup> telematic performance was successful as a first performance; equal to any other first performance of an electro-acoustic concert I’ve been involved with before. The way we conceived of performing telematically, in this case, was as an alternative concert hall as opposed to a new performative model using technology. In fact, there were four concert halls — each with its own perspective: UCSD, RPI, Stanford and the virtual space over the internet.

Our ability to make effective musical choices was directly based on our ability to listen, hear, and interact. Careful procedures of sound check, panning, and mixing certainly need

to be refined, however, the tools seem to be in place to do so. I cannot underestimate the advantage of our weekly rehearsal and careful planning of the logistics for each step.

After the performance, I circulated a questionnaire to all the participants. The questions included:

1. Your name and role in the performance
2. Was this telematic performance successful from your point of view? Artistically, technologically, socially?
3. While performing, did you have a sense of group "presence?" i.e. that you were participating as one large ensemble or rather simultaneous streams (live and remote,) or three separate ensembles?
4. Did "latency" prove to be an issue you were conscious of while participating? If so, how did it affect your choices?
5. What suggestions could you propose to make and improve the telematic performance experience from the artistic, technological and/or administrative levels?
6. Please share any other pertinent perspectives or unexpected observations that may not be covered by these questions.

**A brief summary of the responses:**

- There was a general consensus that our performance was successful on the artistic level, especially considering time limitations.
- There were a variety of responses whether or not a sense of group "presence" was experienced, including perceiving all three senses of space, to only our own.
- There were several valid and useful critiques about improving the rehearsal process, including the use of text chatting to address tech issues.
- There were different reactions to the ease of performing telematically but surprisingly there was unanimous impression that "latency" was not an issue once we were performing.

In my experience of latency, there was one moment while co-conducting "Water Naught" with Sarah Weaver; I could see and hear her preparing a group cut off with Tintinnabulate. Recalling that our video software, IChat had a greater latency than the audio, I followed the aural cues from Sarah rather than the visual cues, resulting in a unison cutoff.

In our concert, we did not test the limits of playing 'in time,' i.e. steady tempo. When there was synchronous tempo, it was visually cued, and occurred only locally, not between groups and locations. I wonder what automatic listening/interpreting skills will we develop, if any, to equalize this inherent temporal delay of twenty milliseconds? Will the medium lend itself to any novel solutions in performing time based music? I would be interested in investigating the temporal tolerances in telematic performance.

### **Social Dimension**

The most intriguing aspect of this process has been on the social and human level, not on the technological one. Telematic communication is rarely plug and play. This kind of dialogue requires a new level of patience in interacting with others; with a commitment and will to communicate. In many ways the improvisatory sensibilities of quickly assessing a situation, determining the right choices, tempered by the reality of what is or isn't possible, with the will to "make it work" are the operative principles.

Telematic communication promotes a unique sense of group sharing. Each tool has a different communicative "tempo" allowing for different types of information. For example, chatting, has dual characteristics — on the one hand there's a more contemplative quality due to the time it takes to type out an idea, but it's still a way of communicating contemporaneously with someone. I find this way of tele-collaborating not only effective for sharing ideas and info, but in its own ways, subtle and equally conducive to sharing feelings, humor, and real creative interchange.

There's a kind of telematic etiquette, which Pauline Oliveros has identified about group space, where one is always conscious of virtual communicants. In my interaction and collaboration with Sarah Weaver, day-to-day communication through SKYPE and chatting, took on new dimensions that went beyond email missives. It was a true creative communication, akin to music making, but at a different "tempo."

Sarah Weaver and I would audition ideas and organize the logistics for each week's class. Prior to this project, I barely knew Sarah, yet for the past three months using the telematic tools we've communicated daily and in depth from three thousand miles away. I feel that I've shared with her a unique kind of collaborative process, one that I can't imagine having happened any other way.

### **Conclusions**

Telematic performance isn't a replacement for live performance, but rather an alternate venue that has the potential of artistic intimacy. Telematic performance will only transcend the novelty stage, if there is a performance practice that is driven by rich art making ideas.

The November 16, 2007, concert continues to reverberate, thanks to new friendships, deadlines, and the need and will to make something rewarding happen. I look forward to mining the musical and interdisciplinary art possibilities of the future.

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### **Changing the Distance:**



## Tapes from Greece, and the Building of Community through the Telematic Medium

Jefferson Pitcher

My introduction to the Telematic medium began in the fall of 2006, during my first semester of graduate school. I had moved east from a vibrant live music community in the San Francisco Bay Area to study with Pauline Oliveros, in Troy, New York, where things were generally much less “lively.” I was admittedly reluctant to both accept and immerse myself in this medium in particular, for music had always been about intimacy to me; the intimacy of connecting on a deep emotional and musical level with other humans in the *same room*, making sound. This is ultimately the very *definition* of “music” to me, and the part about “*the same room*,” has always been at its core. Any efforts I had made previously to play music with someone over the phone, or to send recordings back and forth for overdubbing in Pro Tools, Digital Performer, etc., had always felt clinical. The dry and detached feeling of this process was to some degree what drove me *further* in the direction of free improvisation, for I so desired human contact and immediacy. I wanted something that could only exist in *one* place at *one* time, which to me was a microcosm of daily existence. I wanted what Derek Bailey describes in his book *Improvisation* where he writes (I paraphrase), that one has only fifteen seconds to decide what fifteen seconds of sound s/he will make while improvising.[1] Somehow, this process of playing music with people through the computer world just didn’t seem immediate and alive to me. It seemed instead, cold and lonely. I tried telling myself that it theoretically *should* be the opposite, it should feel warm, but I just couldn’t embrace it. But then something occurred. Over time, perhaps similar to the way that one learns a language, I came to a new understanding of this world, While I had not really altered my perception in any grandiose way, by the time of our concert on November 16<sup>th</sup>, 2007, after one solid year of involvement, I became aware that *something* was shifting in me, and that night the continent loosed from the mainland, and drifted out to sea.

After the performance, I was driving home thinking about communication and the mild shift I was feeling. My routine (as much as I don’t like to admit that I have routines) is that I drive up the driveway, climb from the car, gather my things, enter the house, and find my wife and dog. In the later hours of the night (from about 9pm on) the dog, who incidentally is completely deaf and has taught me much about sound, is usually sleeping and does not notice my entry. That night I walked in the house, both rejuvenated and weary from the concentration needed for the evening’s performance, which was by far the most successful I’ve yet experienced in this medium, and found immediately on my wife’s face that something was terribly wrong. I could see that she had been crying, and as is the case in such situations, my heart leapt at the fear of what news I would now be receiving. Selfishly, I imagine I was wondering how and to what degree my life was

about to change.

“Your cousin Beth killed herself today,” said my wife.

I’m not entirely sure how to describe in words the feeling that my heart and body experienced in that instant, so I will not attempt. Suffice it to say, I felt an extremely deep sadness for her parents, her children, and her husband. There is also a certain terror and confusion about mortality when such news strikes. I chose not to go to the funeral, a fact about which I am dealing with some lingering guilt, because my wife had been having complications with our first pregnancy. The weeks since have effected me in a number of ways. I felt the waves of a terrible grief cresting and crashing through my family, and the helplessness of being unable to do much beyond a letter to tell them that I love them, that life will somehow carry on. Somehow. Equally important, I have felt more alive than at any other time in my life; incredibly grateful to awake each day. While I could write a great deal about this moment in the forest of my life, I am here at this keyboard, with this machine on my lap, to write about telematic music. And yet recently, I came to realize that these seemingly disparate elements of existence are indeed related to one another. Perhaps I discovered that Telematic music holds at its center, some secret of existence; that by reducing distance between humans and their communication, we are eliminating time, and therefore disrupting the process of mortality. But *that* is not the connection that I seek. The connection that I seek to explore here is much simpler.

Though I’ve not studied this academically, I’m inclined to believe that when we lived in smaller communities, clusters of society where people knew all of those who lived anywhere near them, we were less inclined to feel alone and disconnected from the sea of humans that make our “lifeblood” flow. I imagine that rates of depression have most likely increased per capita as more and more people have moved into the cities and out of agrarian lifestyles, or lifestyles where community is imperative to existence. Having spent some time in the countryside of southern Ontario, in a small town of 700, I can say with great authority, that it would be quite a bit more difficult to feel isolated from humanity in such a setting. I know that this is a rather reductive view, but this is how I found myself falling in love with the Telematic Medium. It seems to me that we tend to become rather anonymous in big cities, which is to some degree what makes them so alluring. I’m certainly not suggesting that cities are bad, or that telematic music is a means of eliminating the horror of people taking their own lives, but I am suggesting that we as a culture have lost touch with the deep importance of communicating. At its most profound, communication is directly tied to love and a connection with the spiritual elements of the world. In its simplest, it is what allows us to know and make less “strange” the “strangers” in our lives. One of the things I miss most since moving to Troy, is the coop where I used to shop in Northern California. I had come to know the people working there, and though we only knew one another in the checkout line, they told me of places where the owls would feed at night, and where one might spot the

condors in Big Sur. They commented on my old green Schwinn, and my lengthening beard over the months. Though I try, the grocery store(s) here are simply too anonymous. No one seems to remember me, and if they do, they don't talk much when I try to engage them. They certainly don't comment on the changes in my face, and they probably never see my bicycle out front, for the architectural layout of the store does not allow for such window gazing. In this way of bringing people closer through the small details of life, telematic performance can teach us much about community, and about connecting which so many have eschewed in favor of convenience and bright lights. I still choose to go inside and pay for my gas to speak to a person, rather than speak with my fingers to the pump.

Without any form of deep human connection, musicians are simply regurgitating the learned patterns of bodies. While muscular memory is important while making sound, the heart has a bigger role. With the proper attention to listening and "musical speaking," we can with our hearts, and the warmth of our blood, the intricacy of our brains, the complexity of our bodies, bring instruments and ideas to life.

Therefore, telematic performance becomes like all other medium through which we communicate. Our voices. Our eyes. Hands. The telephone. Radio. Recordings. A bull-horn. Newspaper. Concert hall. The endless internet. In the telematic medium we have essentially a new language or a new body, or perhaps an extension of the body; one that cannot *erase* distance, but can *alter* distance. In 1911 French Philosopher Henri Bergson wrote: "Real duration is that duration that gnaws on things, and leaves on them the mark of its tooth. If everything is in time, everything hangs inwardly, and the same concrete reality never recurs. Repetition is therefore possible only in the abstract; what is repeated is some aspect that our senses, and especially our intellect, have singled out from reality, just because our action, upon which all the effort of our intellect is directed, can move only among repetitions. Thus, concentrated on that which repeats, solely preoccupied in welding the same to the same, intellect turns away from the vision of time. It dislikes what is fluid, and solidifies everything it touches. We do not *think* real time. But we *live* it, because life transcends intellect." [2] This I believe is the key; this meditation on distance and time. I remember well, just after finishing my undergraduate studies, that my closest friend moved to back to Greece, where he was raised. As he and I had spent the better part of five years attached at the hip and heart, this was deeply difficult for both of us. We couldn't afford the phone calls, and so were reduced (or expanded) to writing letters. I did not have a computer, and the email revolution had really just begun, so was not a part of cultural vernacular or everyday life at that point. Incidentally, it was in my final year of college that a professor offered extra credit to those of us, who would send him an email. I did so, but wasn't yet able to foresee the way in which it would drastically alter the world, for I was still too in love with the handwritten word. I wouldn't say that my love for the handwritten word has diminished since then, rather I would argue that it has grown and deepened, but I have certainly come to accept it as a

rarer thing. So my friend and I wrote letters. This led to our making cassette tapes for one another, which would often make us both cry. Somehow, hearing the voice of someone you love, recorded three weeks previous, has the ability to bring great tears. It has something to do with time, and distance. This evolved into our decision that we would set times to record these audio tapes, so that although we weren't speaking **WITH** each other in that instant, we were speaking **TO** each other at the same time. This brought us closer; this knowledge that we were both looking at the moon during the same night, peeling back the layers of ourselves. Of course being in an only mildly tolerable version of suburbia at the time, I was nearly as struck by his recording of the Mediterranean Sea as I was his voice. It was as if I could *really* travel there, which I imagined at the time made me feel like early films must have made audiences feel; seeing and hearing things they had never dreamed of.

Slowly, over time, we began to learn how to use the medium of "simultaneous oral-letter taping." We learned what brought our best friend closer. What poetry to read, and what stories to tell. Sometimes, there were moments of long and contemplative silence on both sides, and though we never quite figured out if these silences were occurring at precisely the same time, we felt connected. These packages with letters and tapes became the ground upon which my life was standing.

About a month before Greg came home from his year in Greece, an old friend of mine gave me a laptop computer, which he explained I could plug into the phone jack at my house and go on the internet. I was not entirely sure what the internet had in store for me (I still don't know to be honest) but I was most curious. So after quite a bit of work getting the modem to do its magical thing, I was out there in cyber-land, exploring and wandering, quite like one might do in a city for the first time, with no plans whatsoever where to go and what to do. (Of course with the beauty of this aimless "derivative," [3] comes a danger in both cities and *especially* the internet.) So upon discovering that I had developed such capabilities, Greg, who had been teaching himself to write code for a few years, suggested in a letter (including detailed instructions) that we join a chatroom online, and type together. This too took quite a bit of trouble-shooting on my end, including a number of long phone calls with someone who understood these things better than I, but at some point it finally worked. That moment, when we made our way into the same space out there beneath the same moon, under the same stars, in the same chatroom, was really quite profound, albeit somewhat awkward. It was something like two lovers, removing all of their clothes for the first time. Hurried and excitable, but timid with reservations about how to proceed, and "just what does this mean for the future of things?" "How will this change our relationship?" "Our lives?" "Our world?" "Why are so many of us, so afraid of change?" Anyway, Greg came home a month later, and we were back to sitting around a table with glasses of wine, or a rehearsal studio with guitars in our hands. And yet somehow those evenings fell apart. We drifted, for reasons I never understood, and though I miss him terribly, I only hear from him once or twice a year if I

am lucky, and never much from his heart. As I look back over those years of my life, I am amazed to know that we may have been closer as we sent those tapes back and forth, and maybe even on that exact night when we ended up in that chat room for the first time, than ever before or after. What I learned from all of that, has been invaluable to me during my foray into the telematic medium.

I have been actively participating in telematic performance for one and a half years now, and my mind continually returns to this idea of communication, and our basic humanness. In the same way that we must learn how to speak to different people in different ways, and learn different means of communicating in different languages, the telematic world is one ripe for learning. It is absolutely begging for a new way of speaking. I find that most people entering into any telematic work seem to do so rather nonchalantly, with the assumption that it will somehow be the same as the telephone or letters, or email; and that the music will be the same. I learned quickly that I had to listen more closely and be more comfortable with silence than was common with my playing. And I *love* silence in music. It is amazing to me that this all cycles back around to listening, but it shouldn't surprise me at all. To be less vague, I discovered the importance of space while playing, for density does not travel through space and time very well. The November 16<sup>th</sup> performance was in my opinion, only successful due to the very hard work of the organizers, and the compositions themselves. The compositions respected and created space, and paid great homage to the fact that the medium we were using demands much clarity. There were of course the logistical issues of imperfect sound checks, speakers that were calibrated incorrectly, and other such details, but the overall performance had the necessary elements to be great, and though not always, *was* at times fantastic. I learned that telematic performance is as much about communicating as it is about playing music, which made me realize just how deeply connected those two things are. As much as I feel like I know this all of the time, I am continually shown greater levels of complexity with regards to listening, which suggests to me that I have much to learn. I also learned how terribly important it is to establish a clear path of communication across the thousands of miles, so that the music can grow in that vast space. This may be as simple as designating who speaks and when they speak, by announcing one's name, or holding up a hand, or .....? But then this could also become very complex. I learned that in order to hear the Mediterranean Sea on a tape, to really *hear* it, one must first write the letters that open all of the necessary doors to arrive there.

So on this snowy, second day of December, I think of my cousin Beth. I think of her young children she left behind, and their father who has to somehow carry on. I think of my aunt and uncle and the great, searing pain that their hearts must be feeling. I look over at my wife and her big, pregnant belly, and think about the life that my child will soon embark upon. I hope sincerely that in his life, he never feels so cut off from the world, that he wants to leave before the earth takes him. Perhaps we can shorten the distances between lovers and the lonely souls of the earth within this new medium. Perhaps we can

build communities where people will have a home, a place where they can listen and make the music that lies inside of them, whatever and wherever that may be. Perhaps we can learn to listen more. Perhaps we can send sound out into the world, beneath the same moon, and the same stars, that we can all feel and understand. I believe that this new way of speaking and making sound can truly change our lives, if only we have the courage to allow it. After all, “the function of the artist in our society is ‘to give to see’...art can determine the nature and purpose of humankind in company with ‘non-art’ with technology, with science, and beyond.” [4]

### **End Notes**

- 1) Bailey, D., *Improvisation: Its Nature and Practice in Music*. 1993, New York: Da Capo Press. xiii, 146 p., [12] p. of plates.
- 2) Bergson, H. and A. Mitchell, *Creative Evolution*. 1911, New York: H. Holt and Company. xv, 407 p.
- 3) Harrison, C. and P. Wood, *Art in Theory, 1900-1990: An Anthology of Changing Ideas*. 1993, Oxford, UK ; Cambridge, Mass., USA: Blackwell. xxv, 1189 p.
- 4) Davis, D., *Art and the Future: A History-Prophecy of the Collaboration Between Science, Technology And Art*. 1973, London,: Thames and Hudson. 208, [24] p.

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## **The Telematic Apparatus – Seen from an Instrument Builder Perspective**

### **Jonas Braasch**

Recent increases in bandwidth have allowed to provide a superior sound quality for telecommunication systems, which makes these type of applications more interesting to conduct distributed music performances. A number of collaborations are based on video conferencing systems such as iChat AV or Skype, which are publicly available on the market. Obviously, a distributed music performance is not exactly a conference scenario, and often this form of collaboration is troubled by the fact that systems such as Skype or iChat AV have been optimized for speech conversations.

Generally speaking, telecommunication systems allow the exchange of information among remotely located persons. For a teleconferencing system in particular, the data exchange needs to occur bi-directionally in realtime (full-duplex connection). The

telephone is the oldest and most common type of teleconferencing system. Newer systems like iChat AV and skype differ by a number of improvements from the traditional telephone. The differences include the addition of the visual modality, the possibility to conference with more than one remote partner, and the use of hands-free interfaces such as the speakerphone. Computer-based teleconferencing systems also transmit their data digitally over the internet and not through an analog line. Often, teleconferencing systems are measured with regard to telepresence, the level of realism that can be achieved to give the participants the feeling that they and others are present.

The presence of the telecommunication apparatus becomes less apparent for the individual participants with improved communication. Ideally, the participants would feel that they are sharing the same physical location with their telepresence partners.

An alternative view on telecommunication applications for music performances would be to treat the telematic apparatus as a new type of musical instrument or instrument extension. Like any other instrument that has been introduced in the past, telematic systems provide new affordances while restricting others. The biggest affordance of a telematic applications is arguably that it offers to perform music with everybody across the globe. Unfortunately, new restrictions often outweigh the new affordances. In particular bandwidth restrictions, transmission latency and echo feedback are the most often named problems in music-based telecommunication.

### **Bandwidth restrictions**

While bandwidth restrictions have been a major problem in the past, new technologies have enabled data rates that practically solve the problem. Most Telematic Circle partners have access to INET2 which allows data rates of up to a Gigabit/s or more. Practically, we have been working with connections of close to 100 Megabits per second in both directions simultaneously. The transmission of DV quality video requires a bandwidth of 25 Megabits/s in one direction and 8 channels of CD quality audio about 5.5 Megabits/s.

Most private residencies access the internet with bandwidths significantly less than 1 Megabit/s. However, it can be expected that these values will increase substantially over the next few years. As an alternative, a new class of compression algorithms can be used that allow similar compression rates to the widely spread mpeg or AAC standards with much lower latencies of about 5 ms for the coding/decoding process.

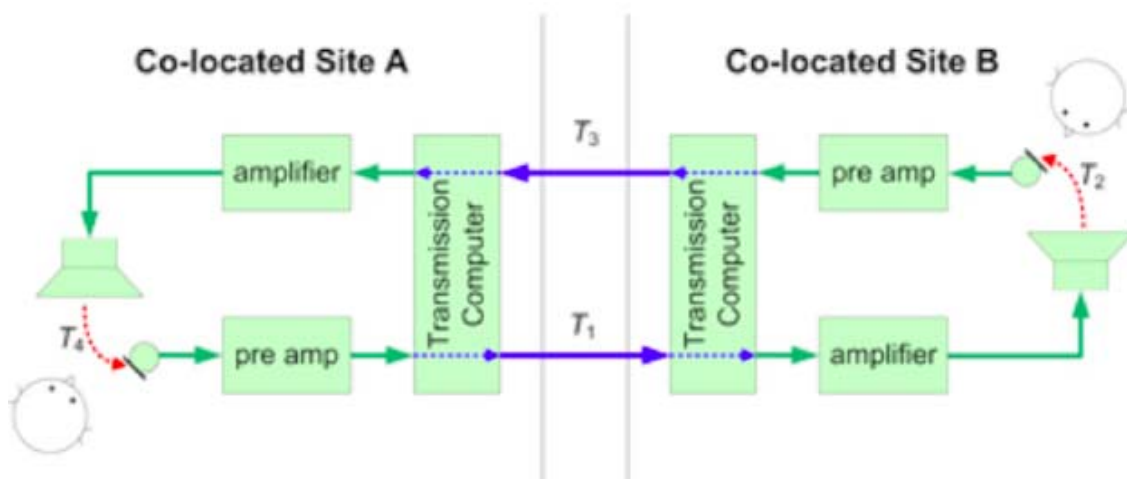
### **Transmission delay**

The unavoidable transmission delay between two or more sites might be the biggest obstacle to create a telepresence environment that offers the same quality level of communication as onsite performances. For most traditional types of music, performers tend to agree that the threshold above which it is difficult to play in sync between two remotely located sites is about 25 milliseconds. The transmission delay consists of two

elements: the transmission delay and a signal-processing delay. The first is determined by the physical length of the connection and the propagation speed of the signal, which is the speed of light. An easy calculation shows that a signal traveling on direct route between RPI in Troy, NY, and CCRMA at Stanford University, Palo Alto, CA would need 14 ms for the distance of 4,111 km (direct line). A connection between New York and Australia (16,000 km) would even take 54 ms, if a straight cable was drawn between both cities. These values cannot be undercut, unless it is questioned that the speed of light is the maximal possible propagation speed. The signal-processing delay, on the other hand, is determined by processes such as analog-to-digital conversion, data packaging, routing processes, and digital-to-analog conversion. With the adequate hard- and software, these processes altogether can take a very few milliseconds only.

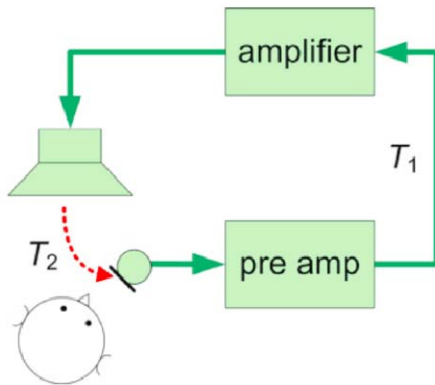
When we speak about distributed music performances, we tend to forget that every performance involving more than one musician is a distributed performance. Even if the musicians share the same physical location, the acoustic information needs time to propagate from the musical instrument to the ears of the participating musician(s). It travels with the speed of sound at only 430 m/s at room temperature. Hence, two musicians that are located 6 m apart on a concert stage face the same communication delay (14 ms per direction) as two closely captured musicians that perform via the internet between RPI and Stanford, assuming that the signal-processing delay is negligible.

The latency requirements for speech applications are typically less strict, but the audio/visual synchronization is important to align the auditory speech cues with the lip movements. The synchronization issue turned out to be not that problematic in our telematic music collaboration, and it was preferred to run the audio ahead with the lowest possible delay, allowing the video signal to take a few milliseconds longer for the compression and decompression process.



**Fig 1:** Feedback loop in a telematic transmission.

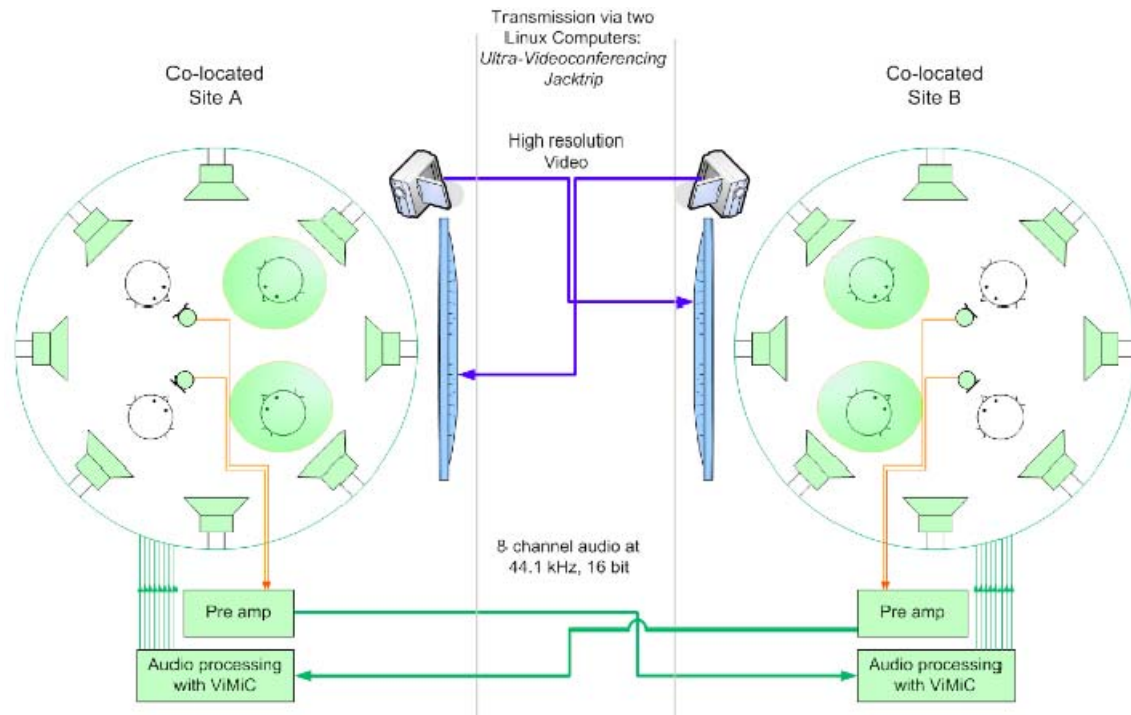




**Fig 2:** Feedback loop in a Public Address (PA) system.

### Echo feedback

Audible colorations and echoes are a common side effect in two-way transmission systems. The problem results from feedback loops that occur, when microphone signal A at Site 1 is broadcasted through loudspeakers at the other Site 2, and being picked up by a microphone B at this site which is then broadcasted back to the original Site A where it is re-captured by Microphone A (compare Fig. 1). Due to the transmission latency the feedback becomes audible as echo at much lower gains compared to the feedback situation known from local public address systems (compare Fig. 2). Many audio/videoconferencing systems such as iChat or Skype use echo-cancellation systems to suppress feedbacks. In speech communication echo-cancellation systems work well, since the back-and-forth nature of spoken dialogue usually allows to temporarily suppress the transmission channel in one direction. In simultaneous music communication, however, this procedure tends to cut-off part of the performance. Spectral alterations are a common side effect if the echo-cancellation system operates with a filter bank. For the given reasons, we avoid using echo-cancellation systems completely. Instead, we capture all instruments from a close distance (e.g., lavalier microphones) to avoid audible colorations. It also helps if at least one of the two sides is at an acoustically treated location with low reverberation times. Since we do not use room microphones, the ambience of the room disappears. To compensate for this, we frequently generate synthetic room microphone signals using a technique called Virtual Microphone Control (ViMiC) [Bra:05]. The system includes a room simulation software to construct a multichannel audio signal from a dry recording as if it had been recorded in a particular room. Both transmission sites share a location virtually, if the room parameters of the ViMiC system are set to be identical at both ends.



**Fig. 3:** Low-latency audio/visual transmission system used by the authors.

### Telematic set-ups for *Telematic Circle* performances

The low-latency audio transmission software *Jacktrip*, which is based on the low-latency audio server *Jack*, is used as a standard for performances of the *Telematic Circle*. *Jacktrip* was developed at CCRMA, Stanford University [Cha:03,Cac:08]. For the transmission of the visual data in DV quality, we commonly use video component of Ultra Video Conferencing, a software that has been designed by Jeremy Cooperstock's team at McGill University [Coo:04,McG:08]. Although, Ultra Video Conferencing has been successfully demonstrated with a bi-directional A/V transmission of uncompressed HD quality, the immense bandwidth needed for this quality makes it not very practical for ongoing collaborations with weekly transmission, and we decided to work with DV quality as an internal standard. Both *Jacktrip* and Ultravideo Conferencing can be executed on the same computer with the Linux *Distribution Fedora Core 6* as operating system. For our concert on Nov. 16, 2007, a combination of *Jacktrip* and *iChat AV* was used, because a three-way transmission configuration is available in both software packages

### End Notes

- 1) [Bra:05] Braasch, J. (2005). A loudspeaker-based 3D sound projection using Virtual

Microphone Control (ViMiC), Convention of the Audio Eng. Soc. **118**, May 2005, Preprint 6430.

2) [Cac:08] Juan-Pablo Caceres, *JackTrip – Multimachine jam sessions over the Internet*2  
SoundWIRE research group at CCRMA, Stanford University,  
<http://ccrma.stanford.edu/groups/soundwire/>

3) [Cha:03] Chafe, C. (2003), *Distributed Internet Reverberation for Audio Collaboration*, Proc. of the AES 24th Int. Conf., Banff, 2003.

4) [Coo:04] Cooperstock, J.R., Roston, J., Woszczyk, W. (2004), *Broadband Networked Audio: Entering the Era of Multisensory Data Distribution*, 18th International Congress on Acoustics, Kyoto, April 4–9.

5) [McG:08] McGill Ultra Videoconferencing Research Group, <http://canarie.mcgill.ca/>

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## Audio Setup and the Future of the Telematic Medium

### Chris Chafe

The 16-Nov concert audio was provided by an experimental peer-to-peer high-def audio streaming application called "jackTrip." It can be freely installed as a part of the "PlanetCCRMA" linux-based sound and music computing platform when converting a PC into an audio workstation. The process creates a clone of the computing environment at CCRMA where jackTrip has been under development. The 3 PC's for the concert were each equipped with multi-channel sound cards, 8-ch at RPI and CCRMA, 4-ch at UCSD. The corresponding number of channels were streamed between sites and mix downs of ensemble feeds were required because of the larger number of players.

Instructions for PlanetCCRMA installation:

<http://ccrma.stanford.edu/planetccrma/software/>

Information about running jackTrip:

<http://ccrma.stanford.edu/groups/soundwire/>

Why hassle with networks in making music together? We share the belief that someday musical contact (and this means communication in the most personal sense) transcends the present state-of-the-art experience which tries to be "almost like being there" to something "better than being there."

University-based experiences utilize Internet2, a network that can support phenomenal numbers of channels at long distance and low latency. As these linkages become more commonplace (and extend into communities outside universities) they will create an "always on" real-time media web that includes a different kind of acoustical medium. The medium has unique sound properties which are beginning to be identified. For example, the perception of distance in the physical world: farther sounds are expected to grow fainter as the delay gets longer — not so in digital audio over networks. Through portals that open into other "rooms," sound can actually grow louder as delays increase (if desired). Or another distinction: conducting with visuals in a room works because the speed of light is faster than speed of sound and synchronization gestures can anticipate musical gestures. Present networking technology flips that around to where sound arrives before image. Adjustments to ensemble behavior are able to be imagined as well as new image techniques, all of which add up to near-term projects for experimental realms and even long-term adjustments to our own perceptual expectations.

We use sounds to learn about the state of our environment and objects in it. Just like in air, sound waves traveling across the Internet can bounce off edges, boundaries and obstacles. These reflections give rise to a configurable sound world of rooms with enclosing walls and other kinds of objects which can vibrate. This world is entered from any where in the physical world connecting with a high-enough speed Internet connection. This presentation describes how music ensembles at Stanford and elsewhere are now coming together and making music in these Internet music halls, and how the relatively short time delays of the Internet can be used to constitute a new breed of synthetic, distributed musical instruments. Short-enough echoes (for example, between West Coast sites) are used to create instrument tones whose pitches are in the musical range. One can actually "play the network" as a guitar or flute stretching between San Francisco and Los Angeles. One application uses these tones to display the quality of the intervening Internet path.

Musicians and network engineers are probing the qualities of this new acoustical medium. Our group at Stanford creates "Sound waves on the Internet from real-time echoes" (SoundWIRE) by using special-purpose software. Employing Internet2 for reliable high-speed streaming, we can create network auditoriums with realistic room-like echoes. Musicians separated by a continent can enter the same acoustical space and rehearse together for jam sessions and concerts. Audio conferencing in these "acoustical chat rooms" achieves a sense of co-location and presence not possible in traditional teleconferencing.

Sound transmission in the medium has its differences from how sound propagates in air (which is itself different from how sound travels in water, through the earth or along stretched strings). The most unusual aspect is the slight non-uniformity of sound travel speed. Synthetically created rooms have slightly changing dimensions as a result, since

the timing and symmetry of echoes depends on the speed of sound inside the room.

The SoundWIRE technique provides a means to gain an impression of the solidity of Internet connections. Just as someone might clap to get a sense of the size of a darkened room or knock on an object to know its rigidity, network users can tap on their Internet connections and listen to the vibrations that result. By plucking a "network guitar," the quality of service (QoS) becomes apparent. Using physical model synthesis we imitate a guitar string whose pitch is a function of the round-trip time of the network path between two sites. The longer the sound takes to make it back, the lower the resulting pitch. And the more constant the tone, the better the QoS and the closer it is to ideal. Because the speed of sound is non-uniform, the pitch of these synthetic instruments may have a wavering vibrato which is easily heard without musical training. An audio "ping" in this form serves as a kind of Internet SONAR to detect problems in real time.

The acoustics of the Internet has a number of other characteristics which will be described in another the presentation. The analogy that comes closest is from underwater acoustics. Entering into these different sound worlds with our ears, the properties of water and Internet media give them a sonic imprint all their own. We know very well the sound of the former and may soon become familiar with the latter.