CCRMA STUDIO REPORT

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ABSTRACT

What's new and changed during last couple of years at CCRMA, with a special focus on The Knoll, our newly renovated building.

1. INTRODUCTION

The Stanford Center for Computer Research in Music and Acoustics (CCRMA) is a multi-disciplinary facility where composers and researchers work together using computer-based technology both as an artistic medium and as a research tool. CCRMA is located on the Stanford University campus in a building that was refurbished in 1986 to meet its unique needs. In 1989 the Loma Prieta quake struck and the whole third floor was declared off limits. It took a long time for the building to get fixed...

2. THE NEW KNOLL

The condition of the Knoll before the renovation fell far short of CCRMA's needs. One third of the building had been lost after the Loma Prieta earthquake of 1989 (the condemned portion was replaced with "temporary" trailer offices located on the same site). Since then the nature of computing and research directions had continued to evolve but the facilities did not keep pace with those requirements. Knowing that major seismic repairs were necessary and would someday be addressed, space acomodations, program upgrades and maintenance items had been deferred.

The renovation meant big changes to the whole building to bring it up to current construction code. It was the perfect opportunity to upgrade it to the current and future needs of the community. The old Recording Studio and its Control Room were the only two rooms in the whole building that did not see any changes. The rest of the floor plan changed, sometimes drastically.

The renovation was also a carefully balanced act between maintaining and in some cases restoring some of the rooms to their original look dating back to the early 1900's, and creating attractive and useful spaces for work, interaction and fun.

Particular attention was paid to creating a quiet working environment and new studios and sound spaces with very good acoustics.

2.1. Highlights

A 100-seat performance hall (the Stage) is now located in one wing of the uppermost story to provide a venue specifically intended for contemporary music performance projects. Carefully designed acoustics have created a very quiet hall that everyone so far loves. At the end of this wing a small multichannel studio (Studio E) is located that can also serve as green room for the concert hall. A flexible Seminar Room and a small kitchen are located next to the concert hall, and the lounge in the middle of the building has perhaps the best view of any room on campus (one side overlooking the hills, the other with a wide unobstructed view of the whole campus). The other wing of the upper floor is dedicated to open shared workspaces and a few offices for Faculty and grad students.

One floor down we find another multichannel studio (Studio D), a fully featured classroom (our main teaching space) and an adjoining open workspace and computer cluster with very wide doors that can join the two spaces together. Another small computer cluster is part of the main lobby area, followed by staff areas and the CCARH shared work area in the other wing.

In the lower floor we have a new location for the MaxLab, a new medium sized studio (Studio C), the old Recording Studio and Control Room facilities, and finally the new Listening Room, an experimental 3d space with almost anechoic acoustics, very quiet and with 16 speakers (for now) in a 4x8x4 full 3d surround configuration (including a pit and metal grid floor that allows speakers to be located below the floor level).

In the main lower level lobby there is now a space for a small demo / museum area that will provide exhibits on the history of music technology.

Noiseless computers are sprinkled througout the building and in all the studios and critical listening environments (more on this below).

By September 2005 (after more than 1 1/2 years of construction work) we had moved into the new facilities.

3. COMPUTING AT CCRMA

We had to get new computers that matched the carefully designed acoustics of the building. When we moved out we were using several generations of computer hardware (off the shelf and custom built Intel/AMD based computers running Linux and the Planet CCRMA environment), ranging from very old, noisy and nearly useless PentiumII

based computers to newer almost silent custom designs based on P4 processors. We wanted silence without compromising the computing power of the machines.

As there was not enough space in the new building to acoustically isolate the new machines (except for closets in the three new studios), and isolation boxes are bulky and not completely noiseless, that actually meant trying to build noiseless computers.

Two approaches were tested, water cooled and completely passive systems. The former, although cheaper, were ultimately discarded as the most promising hardware configuration had a separate water cooling tower connected to the computer with flexible hoses. Cooling fluid leakage accidents were bound to happen with many machines and students interacting in a dynamic environment such as CCRMA. Other water cooled self-contained units had good cooling characteristics, but required the use of low speed fans to cool the radiator, which again create noise.

After much research a satisfactory custom built design was built and tested using commercial fanless passive cases. We set up a small "factory" in the old Trailer B temporary space and with several staff and student helpers doing assembly and QA work we built 40 new fast dual core Linux based workstations with almost no moving parts (the only component with moving parts is the hard disk, which with the proper choice of model is not that much of a problem). It is even possible to get rid of the hard disk noise by booting the machine from a remote server and then turning it off, but that has not been necessary so far.

As an example, our main cluster has around 14 machines and is a quiet room that remains that way even with all machines on and running at full speed. It is now possible to have a machine out in the open in a studio that doesn't interfere with mixing, composing or research activities.

Faster computers and faster networking backbone made the previous generation of servers inadequate, so a push to upgrade them is still going on. Much faster servers for computing and home directory service have been installed, with more network and disk i/o bandwidth than the previous generation.

4. RESEARCH

Here is an incomplete list of research projects that have happened (and are still happening) at CCRMA:

4.1. Signal Processing

Kyogu Lee has been working on automatic chord recognition from raw audio. He introduced a new feature vector called Enhanced Pitch Class Profile (EPCP) to minimize the effect of non-chord tones due to overtones, which may cause confusion for the pattern matching algorithm. He later used machine learning approaches to build a hidden Markov model from a large number of labeled training data synthesized from symbolic files. He is now further extending his approaches to identify musical genres and to extract musical keys.

Hiroko Terasawa, **Malcolm Slaney** and **Jonathan Berger** are conducting a psychoacoustic research project towards a quantitative model of timbre perception. The aim of the research is to find a sound representation which satisfies a direct mapping between the metric and the perception of timbre. They determined so far that a timbre space based on Mel-frequency cepstral coefficients (MFCC) is, potentially, a good model for a perceptual timbre space.

The ongoing **RealSimple** project directed by **Julius Smith** is a KTH (Royal Institute of Technology, Sweden)-CCRMA collaboration devoted to the development of musical acoustics laboratory exercises integrating both hands-on laboratory experience and computer-based simulation.

4.2. New Media and Musical Systems

Rob Hamilton: Bioinformatic Feedback, performer biodata as a driver for real-time composition. A software system using bioinformatic data recorded from a performer in real-time as a probabilistic driver for the composition and subsequent real-time generation of traditionally notated musical scores. To facilitate the generation and presentation of musical scores to a performer, the system makes use of a custom LilyPond output parser, a set of Java classes running within Cycling 74s MAX environment, and an Atmel AT-Mega16 micro-processor capable of converting analog bioinformatic sensor data into OSC messages.

Rob Hamilton: Maps and Legends, an FPS-based Interface for Composition and Improvisation. An interactive multi-channel multi-user networked system for real-time composition and improvisation built using a modified version of the Quake III gaming engine. By tracking users positional and action data within a virtual space, and by streaming that data over UDP using OSC messages to a multi-channel Pure Data (PD) patch, users actions in virtual space are correlated to sonic actions in a physical space.

Greg Sell has been working toward creating virtual acoustic objects from complex data in hopes of revealing pattern and structure. Work to date has utilized the waveguide mesh to create membranes with resonant zones whose size, shape, location, and strength are determined by the data itself.

Woon Seung Yeo and **Jonathan Berger** have been working on Raster Scanning as a new approach to image sonification, sound visualization, sound analysis and synthesis. They propose a data mapping mechanism of raster scanning as a framework for both image sonification and sound visualization. In addition to its potential as a cross modal representation, its complementary and analogous properties can be applied sequentially to create a chain of sonifications and visualizations using digital filters, thus suggesting a useful creative method of audio processing.

Sook Young Won and **Jonathan Berger** investigate the spectral characteristics of one's own voice as compared to that of the recorded air-conducted sound. They conduct a precise self-perception test where the frequency

region of air-conducted sound is altered by peak and shelf filters with varying gain and band edges. The experimental software and interface used here is a real time filtering application for effective comparison of the subject's own hearing with the recorded sound processed using the transfer function.

4.3. Networking and Music

The **SoundWire** research group (**Chris Chafe** and **Juan Pablo Caceres**) uses Internet networks as an extension to computer music performance, composition and research.

On the software side, the group has been developing and testing JackTrip, a Linux-based system used for multimachine jam sessions over Internet2 (now included in PlanetCCRMA). A network reverberator is under development.

Part of the research includes testing how real musical situations with professional ensembles behave under different network conditions (including remote acoustics). Testing has been done with the Saint Laurence String Quartet (SLSQ) distributing its members between CCRMA and the Banff Centre (Alberta, Canada).

Concerts include two Christmas concerts (2005 and 2006) between CCRMA and SARC (Belfast), the Sonorities 2006 Festival closing concert (Stanford/Belfast, May 2006), "100 Meeting places" 4-way concert (New York/Chicago/Santa Cruz/Stanford, March 2007) including live audiences in all 4 locations.

The project has also been developing long term musical collaborations using network technologies. We took part in a two quarter sequence (fall 2006, winter 2007) of weekly rehearsals with Pauline Oliveros' improvisation class at RPI (Troy, New York), and later also Cynthia Payne's ensemble at UCSC, which included a 4-way (100 Meeting places) concert at the end of March 2007.

4.4. Controllers

Woon Seung Yeo has been working on The Bluetooth Radio Ball Interface (BRBI, pronounced Barbie). It is a novel wireless ball interface for sound control and motion sonification. Inside a soft, easily grasped palm-size foam ball is a Wireless Accelerometer / Tilt Sensor that contains a 3-dimensional accelerometer/tilt sensors and a Bluetooth transmitter on a single board to send out measurement data to a Mac. Data is processed by WiTilt to OSC, a program that decodes binary inputs and re-formats them as Open Sound Control messages.

Steven Backer, **Per Bloland**, **Edward Berdahl** have been working on an electromagnetically augmented piano. By positioning a rack of transducers above the piano's strings - but never in physical contact with the strings - electromagnetic waves in the air gap create vibrations and sound from each of the piano's many naturally oscillating strips of steel. These transducers are connected to the soundcard output of a personal computer, where audio output signals can be specified through any arbitrary software interface. The net effect, captivating as both a sound and an idea, is the ability to play the piano without felt hammers, plectrum, fingers, or any other traditional method of physical excitation.

Edgar Berdahl has been researching new musical instruments that promote control intimacy, as well as researching the applications of control engineering to computer music. This includes actively controlled instruments, in which the acoustical dynamics of a musical instrument are altered so that the instrument behaves differently. Berdahl is working on the haptic drumstick, which is familiar to every percussionist because its basic behavior is the same as a real drumstick. The haptic drumstick's structural dynamics can, however, be altered to provide the percussionist with a sort of "power steering."

4.5. Software

Planet CCRMA: **Fernando Lopez-Lezcano** has been working hard on keeping up to date with the most recent versions of sound, music and midi Open Source software for the Linux platform. Planet CCRMA currently runs on the latest Fedora Core releases.

Bill Schottstaedt has continued work on Snd and CLM / CMN. Many changes and additions (too numerous to mention here), Forth, Gauche, various new CLM generators, sound effects, Cairo support, more header choices, etc.

5. COMPOSITIONS

Jonathan Berger: *Jiyeh Part 1*: for computer generated and processed sound first performance: A Concert of Music on Ecology and the Environment, CCRMA, November 9 2006 at the Imaging Environment conference, Stanford University.

Part 2: concerto for violin, string orchestra and percussion (2007) - premiere April 23, Palo Alto, California

Per Bloland, *Elsewhere is a Negative Mirror, Part I* (2005) for solo piano with electromagnetically controlled resonance.

Negative Mirror Part II (2006) for flute, clarinet, violin, violoncello, percussion, and piano with electromagnets.

Quintet, for solo saxophone and electronics (2005) for solo saxophone and live electronics.

Juan-Pablo Caceres released a new album of his music *Orquesta*, through the Innova label.

Chris Chafe: *E=M2C* (2007) Roberto Morales (flutes, piano, laptop), Roscoe Mitchell (saxophones, percussion), Chris Chafe (celletto). Presented by Stanford Music Department's Chamber Music Live. Saturday, October 7, 2006

Replication (2006). Score for piano and computer music, with computer-generated conductor for rehearsing timings (animation by Greg Niemeyer).

Scatter (2006). Score for soprano and computer music, with computer-generated conductor for rehearsing timings (animation by Greg Niemeyer).

Score IV (2007). Score for radio baton, with computer-generated conductor for rehearsing timings (animation by Greg Niemeyer).

Celletto Concerto with Internet Ensemble (2007) a part of "100 Meeting Places", A 4-way concert involving four venues across the United States. Tintinabulate Ensemble directed by Pauline Oliveros, RPI at Troy, New York. DANM at Santa Cruz, California. Weave Soundpainting Orchestra directed by Sarah Weaver, Loyola. University in Chicago, Illinois. CCRMA at Stanford, California

Rob Hamilton *Triages* for flute, clarinet, violin, cello, piano, electric guitar and computer. The piece was premiered on April 28th at CCRMA's Stage at the evening concert.

Fernando Lopez-Lezcano *Kitchen ¡-¿ Miniature(s)* for multichannel playback. This 8 channel piece was premiered during the NewStage CCRMA Festival in 2006. It is now a full 3D version for 24 channels that has been played in concert at the SARC auditorium in Belfast. Downmixes of the latest version have been played in the Tesla Auditorium in Berlin (as part of the LAC2007 conference) and at DXARTS in the University of Washington.

Bruno Ruviaro and **Juan-Pablo Caceres** won the First Prize on the Digital Arts Awards 2005 for the piece *Chamber of the Late Half-Hour* (electroacoustic, 4 channels). Keio Research Institute, Japan, November 2005.

Bruno Ruviaro *Instantnea* (prepared piano and live-electronics) was played in Rio de Janeiro (Biennial of Contemporary Music, 2005) and New York (MATA Festival, 2007)

Aaron Trumm composed, recorded and mixed techno / classical / poetry fusion music in stereo, 5.1 and 8 channel surround formats. Most of his time was spent on the project *Four Hard Edges Of War* under an act called Third Option which he had previously released several CDs under.

6. BOOKS

CCARH

Music Analysis East and West (Computing in Musicology, 14). Cambridge, MA, The MIT Press, 2006.

Music Query: Methods, Models, and User Studies (Computing in Musicology, 13). Cambridge, MA: The MIT Press, 2004.

http://www.ccarh.org/publications/cm/vol/13/

J. O. Smith,

Mathematics of the Discrete Fourier Transform (DFT) with Audio Applications, Second Edition. W3K Publishing, http://w3k.org/books/, 2007.

http://ccrma.stanford.edu/ jos/mdft/.

7. CONCERTS AND EVENTS

7.1. newstage: CCRMA at the Knoll

To mark the renovation of The Knoll, our home at Stanford University for the last twenty years, CCRMA hosted a three-day festival of music and scholarship, April 27-29, 2006. As one of the world's premiere institutions combining technology and the arts, the Center for Computer Research in Music and Acoustics has become a magnet for talented and creative individuals. CCRMA invited current and former members of the CCRMA community to celebrate this new stage in our history with a series of three concerts and lectures commemorating the center's rich history and future. Musical works featuring: Andrew Schloss, Chris Chafe, Roberto Morales, Per Bloland, Dexter Morrill, John Chowning, Bruno Ruviaro, Juan Pablo Caceres, Robert Hamilton, Naotoshi Osaka, Michael Edwards, Kui Dong, Mark Applebaum, Jonathan Berger, Seungyon-Seny Lee, Fernando Lopez-Lezcano, and many others as well as CCRMA family musical talent.

7.2. Computer Music on The Farm: The Beginning A CyberSound Celebration

CCRMA hosted an exploration of the beginning stages of Computer Music at Stanford and a celebration of works by Stanford Music Professors Leland Smith and John Chowning. There was also be a special tribute to John Chowning from the members of his 1966 Freshman Seminar "Science, Music and Man," October 14, 2006. This event included panel discussion with: Max Mathews, John Chowning, Les Earnest, and Leland Smith and music by composers: Leland Smith, John Chowning, J.S Bach, and Henry Cowell.

7.3. MaxFest

CCRMA hosted a celebration of Max Mathews' 80th birthday and 50 Years of Computer Music with a weekend celebration called MaxFest, April 26-29, 2007. This celebration included a performance of Henry Cowell's Rhythmicana performed by Max Mathews on Radio Baton and the Stanford Orchestra. The Rhythmicon rendering for the Radio Baton was developed by Leland Smith. Per Bloland and Mark Applebaum shared the list of feature composers this evening. The weekend ended with a series of talks and a concert at the Computer History Museum in Mountain View with works by: Jon Appleton, Gerald Bennett, Jean-Claude Risset, Chris Chafe, Evelyn Gayou, and Dexter Morrill.

7.4. CCRMA Concert Series

CCRMA has an ongoing concert series which features pioneers of electronic music, live established and emerging new composers and performers. Recently we've hosted: "GRM Presents" with works by Daniel Teruggi and Evelyne Gayou; Nicholas Isherwood; "WireGriot" with Camille Hesketh, soprano Juan Parra Cancino, electronics; Stefan stersj, Duo Alterno; Chryssie Nanou; Eliot Gattegno; Graeme Jennings; Pandit Nayan Ghosh with Ramesh Mishra; Moh Alileche Ensemble; C.R. Kasprzyk; Trevor Wishart; Mark Applebaum; Morton Subotnick; and Stefano Scodanibbio.