The Expanded Instrument System (EIS)

Authors:

Pauline Oliveros
156 Hunter Street
Kingston, NY 12401

Pamestis
15 Hope Street
Kingston, NY 12401

Abstract

The Expanded Instrument System (EIS™) for live performance has been under continual development since 1983. The EIS in its current form is a performance environment consisting of a network of time delays, mixing routes, microphones and a multichannel speaker configuration. Acoustic instruments are the preferred signal sources. Performers are able to "expand" the sound of their instrument through interaction with the various parameters of the delay and effects processors, which can modulate the sounds and change the perceived quality of the space in which the performer is playing. The delay processors are controlled through a non-MIDI based central network using foot pedals and computers. The current delay processors will be replaced by a Reason® processor that will provide digital mixing, resonance processing, and will potentially handle external DSP via a MAC II computer.

This paper describes the derivation of the EIS, its current status, and the projected goals for its development. It also describes the evolution of unusual interactions between performers that have resulted from the system's development process.

KEYWORDS: Performance electronics, performance interactions
Introduction

The influence of the characteristics of different acoustic spaces on the sound of instruments and voices in live performances is a continual fascination for composer/performers Pauline Oliveros, Stuart Dempster and Penelope. In addition to more ordinary venues, all have traveled to remote locations to perform in unusual environments: Stuart Dempster in the Great Abbey of Clément in Avignon, Pauline Oliveros in a reverberant underground cistern in Cologne, and with the Deep Listening Band (Dempster, Oliveros and Penelope) in a limestone cave in upstate New York and a cistern at Fort Worden in Washington state. Such experiences with natural resonances, echoes and reverberation throughout their careers led naturally to the desire to alter and manipulate space during the course of a performance to create spatial progressions as one would create harmonic progressions or timbral transformations—to treat what is usually assumed to be a static container, the acousic space, as another dynamic parameter of music.

History


Penelope has been experimenting with spatial manipulation since 1977 beginning with an brass fanfare that used canonic writing and performers spread to the hall’s extremities to simulate delays. A later work “Duet for Dancer and Vocalist” utilized 8 microphones to distribute the sound to eight speaker locations. At the University of California San Diego he worked extensively with the EAR, which offered tremendous opportunity to test ideas of localization, relocalization, and movement of sound, as well as the transformation of the perceived hall space during the course of an act or scene. In 1987 Oliveros and Penelope began to work together.

Before Penelope joined her in this work, Oliveros performed alone, attempting to control all of the processing with knee, foot pedals, and faders while also playing her instrument (the accordion). She was able to m ake rudimentary spatial shifts and timbral changes as well as layering and pitch bending. As her experience with this crude system accumulated she felt the need for more processors even though how to control them as a performer was an issue. With Penelope the number of processors was increased from four to eight and more speaker arrays were used in their numerous performances together. With Stuart Dempster and David Gamper they formed the Deep Listening Band and began extensive explorations in their residencies and performances of the possible performance techniques with the EIS in this form. Only the limitations of analogue mixing consoles and lack of suitable controllers prevented their using many additional processors.

Current system:

The Expanded Instrument System (EIS) is a collection of microphones, amplifiers and signal processors manipulated with a variety of controllers in complex networks through meters and mixers in a multi- channel system. The EIS accepts input from any acoustic instrument or voice or electronic instruments. The EIS is intended to give the composer/performer control over the apparent acoustic space. Numerous delays of direct sound can be maneuvered and heard as new acoustic spaces. One can dwell in a selected space or change spaces as rapidly as the limits of the processors allow. The results involve the sound of the instruments or voices as well as the space in an interactive process. One analogy could be to imagine how a bet might perceive sounds sending and receiving signals as it flies through space. Or how the reverberating nuances of sound return to the moving whale as it sounds the walls of the oceans. The EIS expands space and expands a performer’s notion of the scope of their instrument bringing new challenges to listening and performing skills.

The EIS itself is in constant development and expansion. Below is a brief description of the components and configuration of the current system.

Microphones:

Microphones and pre-amps are selected for the most faithful reproduction of the voice or the instrument. The microphones are configured to serve two distinct functions: to isolate acoustic sound sources and to facilitate signal routing of a single source. Several microphones are configured to isolate the left and right hand sides of Oliveros’s accordion enabling each to act as a discrete instrument that can have its own distinct processing. On the other hand, Penelope uses two vocal microphones, allowing him
to quickly change from one set of processors to another (or use both) without manipulating the routing at the mixing console.

**PCM 42's**

A stack of four Lexicon PCM 42 digital delay processors, the current heart of the EIS, simultaneously serves multiple functions. These processors have the advantage of a voltage controlled variable sampling clock that allows smooth pitch bending and simultaneous delay time variations. This is analogous to having four variable speed tape decks with variable distances between the playback and record heads. Signals are routed to use these processors in three different configurations:

1. Each sound source is sent into a separate processor.
2. A particular source is sent through multiple processors.
3. A source is sent through a processor and the processors are routed in series.

In practice, these configurations are usually combined to create a complex texture of sound, movement, and sonic transformation.

While the delay processors are used to transform a sound (echo delay, pitch bending, etc.), they are also used to relocate the sound sources and when carefully manipulated, can give the illusion that the sound is moving through the space. Each processor is routed with a bias towards one or at least four speakers that are set up in the standard sound configuration surrounding the audience. Sound may be given perceived movement in two ways. A single source goes through each processor with each set at a different and often varying delay time, or the delays are routed in series. Since it is most likely that the sound will be transformed in some way as it passes through each processor, we have the added feature that the sound is changing while it is moving.

**PCM 70's**

A stack of four Lexicon PCM 70's are used in conjunction with the PCM 42's to add hall and space effects. Spaces are based on acoustical models but don't necessarily exist in the ordinary world. Again, these processors can be routed either in parallel or in series to create very unusual spaces. Since these processors do not elegantly go from one preset to another, they impose certain restrictions in so far as changing presets entails feeding one set out (often they are manipulated in pairs), changing their settings, and then bringing them back in. Each change then creates a complex change in hall characteristics as the transition is made.

**Mixers**

The ideal console enables any signal to be routed to any processor and speaker with each signal node independently adjustable. In practice, anything but a 2x16 matrix mixer poses signal path limitations, but a matrix is too cumbersome to manipulate when re-routing entails simultaneous changes at several points. One of the more effective solutions has been to use a more standard console and bring each processor into the board through multiple inputs with each input dedicated to a particular processor function. For instance, a section of the console is used exclusively to control the feedback routing of the PCM 42's back through themselves, and another section used to control their signal feed into the house speaker system.

Another similar solution is to use several consoles that serve varying functions. Unfortunately, this means that most of the signal sources (microphones as well as processors) must be fed into each console.

**Controllers**

Control of the EIS is always a major dilemma. With both hands occupied by the accordion, Oliveros made compromises in trying to manipulate the PCM 42's. Foot controllers are used, but without these massive devices are cumbersome to manipulate. Currently under development are alternative multidimensional foot controllers that have functionality switching. The first of these is the PanPaw, a three dimension controller that can also be used as a computer mouse.

While in residency at the BANFF Centre in Alberta, Canada in 1990, Oliveros and Panaitoiu tested the second generation version of a custom interface that allows computer control of the PCM 42's (which takes voltage control input and are not MIDI controllable). The interface has two D-0 ports that accept input from a Mac Plus type mouse with each axis of mouse movement controlling a discrete parameter. In addition, there is an RS232 port that allows serial communication to a computer. Max software using custom device drivers are used to control the PCM 42's.

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Performance Interactions:
With signal processors and sophisticated sound systems, it became possible to temper with the container in imaginative ways in real time. The apparent acoustic space can expand or contract, assume new angles or surfaces with the resulting resonances and reflections all varying continuously and affecting the sound of one's instrument or voice while performing. Such changes affect timbral colors in a variety of ways and the audience and performers can experience sensations of walls moving, of moving in space, as well as of sounds moving through space. They can also experience the relationship of moving in space in relation to sounds moving in the same space and while the space is itself changing. Although such audio illusions are not new, with the current ability to have real-time performance of these parameters, space and acoustics now become a musically viable compositional element much as timbre became new in Klangforsen melodie.

With extended delays a performer is constantly listening to something that was created in the past while performing in the present something that will come back sometime in the future: real-time/multi-time performance.

With limited but multiple processors the configurations to which performers are assigned to use vary greatly from performance to performance. This variety imposes specific types of performance interaction. One of the more common of these combinations is that Oliveros will play accordion and simultaneously manipulate the PCI 42's while Penelitosis sings and manipulates the sizes and resonances of the space. If one considers the hall and the localization of sound in that hall to be a musical instrument, these works become duets between sound and space.

The EIS is an extended instrument that is manipulated by several people simultaneously. The notion of community performance is heightened by the fact that each performer has only partial control over the outcome of what one/they produce with an instrument, but one can look at the hall empty and realize that at the same time, each performer has direct control over several instruments. Carried to an extreme, this brings up an interesting form of improvisation. Although much of the work that Oliveros and Penelitosis have created together while performing Oliveros' works have touched on this notion, they formalized this concept during a residency at the BANFF Centre. Penelitosis then put it into practice in his "Peer Censors," which was premiered with the Deep Listening Band at Life On the Water Theater in San Francisco the following fall. In this piece audio signals generated by each performer are routed through a particular signal processor. Each processor is given two controllers that control different parameters of the processors. However, the controllers are not controlled to someone else's processors, and this routing is done before the piece begins without anyone knowing who is controlling who's processor. This means that each performer is in partial control of three instruments and must share the responsibility of the outcome of the generated sound with two other performers. This form of interaction is a collaborative effort that intensifies the act of listening since one must be actively aware of the detailed produced sound coming from at least three musical instruments and understand how they directly control each instrument.

Future Goals
As computers become more and more powerful, many of the limitations encountered in realizing the EIS can be overcome with further development. A single stock of four PCI 42's is adequate to process the sound of one performer. Ideally, each performer should have the equivalent of one stock to themselves. This entails a tremendous amount of signal routing, which should be controlled as much as possible on a macro level of adjustment. In addition, with more to control one needs more ingenious methods of controlling the various parameters while performing an acoustical instrument. Creative solutions to these needs will be explored as the instrument expands in time, in size, and in space.

Bibliography

Discography
I of IV—Pauline Oliveros, included In New Sounds In Electronic Music. Odyssey 32 16 0160
The Roots of the Moment—Pauline Oliveros with Penelitosis (1980), HatArt
Crane Music—Pauline Oliveros with Penelitosis (1990), Lovely Music
Stuart Dempster in the Great Abbey of Clement VI—Stuart Dempster, New Albion

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