The Expanded Instrument System: New Developments and Implementations

David Gamper and Pauline Oliveros
Pauline Oliveros Foundation
PO Box 1956
Kingston, NY 12402

Abstract

The authors describe recent insights and developments of the Expanded Instrument System (EIS), a performer controlled delay based network of digital sound processing devices designed to be an improvising environment for acoustic musicians. Since its introduction to Leonardo Music Journal readers by Pauline Oliveros in Volume 5, the EIS has undergone a continued evolution, while remaining grounded in Oliveros' practice of Deep Listening. The technical changes made by composer and performer David Gamper have been incremental, keeping the user interface as simple as possible and changing functionality as compositional and performance experience demand. The core of the current configuration has proved to be flexible and adaptable to many demands, several of which are described. The authors include examples of how experiencing the Expanded Instrument System has influenced and been influenced by the aesthetics of the musicians using it.

Introduction

The Expanded Instrument System (EIS) [1] is a performer controlled delay based network of digital sound processing devices designed to be an improvising environment for acoustic musicians. [2] It emerged out of Oliveros' solo performance and composition work with tape and digital delays beginning in the late fifties and grew to accommodate additional performers. Gamper was one such performer, whose musical work with delays since the late sixties found a natural partnership with Oliveros' when he joined Deep Listening Band in 1990. As the EIS nears the end of its first decade, its longevity as a performance system is in part the result of recent developments, as it has undergone a slow but significant evolution and expansion of its application over the last few years since it

was introduced to Leonardo Music Journal readers by Oliveros in Volume 5, 1995. [3] In 1993 Gamper conceived the new configuration as one he could quickly implement as a solution to the immediate need to increase performer control of the technology of the previous system. The EIS has since been extended to provide for guest musicians with limited learning time, adapted to various compositional requirements, and been explored by numerous composers and musicians during extended installations and demonstrations.

Through our extensive experience with the Expanded Instrument System, we have come to understand how the requirements of performer control of a sound processing environment for improvising musicians differ from those of more strictly compositionally deterministic systems, even though the technologies may be very similar and improvisation may play a part. Improvising with variable delays and changing ambiance requires intense listening with minimal distractions of technical requirements. Having extensive choices when using the technology involved requires a clear, easily learned user interface. Since most instrumentalists' hands are fully occupied with their instruments, their feet often end up as the most precise and expressive means of independently operating controllers. These controller devices need to be kept to a minimum in spite of proliferating numbers of parameters to control. Scarcity of financial resources encourages use of existing inexpensive mass produced equipment, with customized devices added only when commercial markets do not provide solutions for coveted features.

In this article, we will describe some recent technical developments and relate how the current configuration of the EIS has expanded our (and others) compositional and performance activities.

Recent Technical Developments

In the current configuration of the Expanded Instrument System, each performer has appropriate microphones, a computer [4] and a collection of sound processing devices. [5] "Expression" type foot pedals and switches are interpreted by the computer to control the signal routing from the microphones among the sound processors, as well as control functions of the processors themselves. Each of these set-ups is referred to as an EIS station. [Fig. 1] Sound outputs from each station are

distributed to speakers encircling the performance and audience space. [6]

On the computer screen, the performer sees a display of the available functions to be controlled and their current state. [Fig. 2] This is critical, because many of these functions are actually controlled by a single pedal, which is switched to control the desired function. This "multi-function" pedal is what allows us to keep the number of pedals confronting the performer to a minimum. Although the labels for the functions are necessarily cryptic due to screen size limitations combined with readability constraints, they have proved to be readily decoded with a little practice. There is also a function which allows the user to store and recall sets of function settings. All of this is usually controlled by foot pedals and switches.

Since it is unlikely that a performer has continuous practice time on the EIS, over the years Gamper has been careful to gradually add functions to be controlled in order not to confuse regular users with a frequently changing interface and configuration. The recent addition of a modulation function bears discussion because its depth has the potential to confuse when first experienced.

In the previous configuration, [3] modulation of the read/write speed of one of the delays was controlled through two functions conceptually borrowed from the front panel controls of the Lexicon PCM 42 [7] where three knobs control the wave shape, depth, and speed of modulation respectively. This has the effect of modulating the pitch of whatever sound is being delayed. It soon becomes evident that leaving the depth and/or speed parameters unvaried often becomes very static musically. When we substitute a more complex modulation function, incorporating random variations, the results are more satisfying. In implementing this, Gamper programmed various modulation algorithms in which one pedal controlled function chooses the algorithm (Mtype in Fig. 2) and another varies some aspect of it (Mctrl). These algorithm "patches" are modular and can easily be modified or replaced by the programmer. In fact, one algorithm (named LightningBox) is actually an editable (though not in performance) sequence of the other algorithms. [8]

Finally, an interface which successfully implements the computer control of the vintage PCM 42 delay has been designed by Gamper and

engineered by Bob Bielecki. This interface, nicknamed the BGBox, is a hybrid digital and analog system using MIDI for computer control, but retaining the smooth analog control which is so much a part of its use as the heart of the EIS. Although the number of functions to control is greatly increased, the addition of a function for switching to additional multi-function pedal screens (the Switch function in Fig. 2) keeps the proliferation in check. Extending hands-free functional control to the PCM 42's has also enabled simplified installations without giving up control of many well loved parameters of the EIS's sound processing. The PCM 42 provides the warmest replay of acoustic sound of any processor that we know. Until another instrument achieves this the PCM 42 remains our delay of choice.

Recent Uses in Performance

The current configuration of the Expanded Instrument System has proved to be flexible and extensible in a number of recent performances and recordings by Deep Listening Band (Oliveros, Gamper and Stuart Dempster). For each of the following, Gamper was able to adapt the EIS with relatively small adjustments to the programming and patching.

In 1994, pieces by Ellen Fullman and Pauline Oliveros were commissioned for Deep Listening Band and Fullman's Long String Instrument. [9] Two week-long residencies allowed Gamper and Fullman to experiment with adapting the EIS to her unique instrument. Fullman was especially taken by the ability to bend and sustain her tones. Her TexasTravelTexture combined the acoustically powerful Long String Instrument ensemble with Deep Listening Band with EIS and occasional EIS processing by Fullman through her EIS station. In contrast, Oliveros' Epigraphs in the Time of AIDS featured Deep Listening Band and Fullman as a quartet with EIS, with the other Long String Instrument players as a quiet underpinning.

On April 6, 1996 Deep Listening Band gave a three site concert with Oliveros in Chicago, Dempster in Seattle, and Gamper in New York linked by PictureTel audio and video via The Kitchen (New York, NY). Each performer had an EIS station which could communicate with the station in New York, although unrelated technical problems precluded this communication at the time of the concert. The PictureTel technology introduces significant sound delays of its own, so that although the delay based EIS processing was an appropriate match, the experiences of the

audiences (and performers) at the three locations was interestingly different. [Fig. 3]

The number of discrete EIS stations is limited only by available equipment. Although each station can receive microphone inputs from other performers, guest musicians are often provided with a guest station simplified for the practice time available. One guest configuration Gamper originally programmed for baritone Thomas Buckner, substitutes a set of faders for the foot pedals. This configuration has been further adapted to be able to switch between faders and pedals and was used during the large, extended Non Stop Flight concert at Mills College on September 16, 1996. [10] A number of composer/performers had the opportunity to learn to use that guest station over the preceding week and occupied it during the course of the concert. The system was also programmed to send foot pedal data to The HUB (a networked computer and synthesizer performance group), which used the data in one of their pieces. In addition, the guest station processed their and others sounds while being remotely controlled by their network.

Another compositional approach was taken by Joe McPhee for his commissioned work Unquenchable Fire (1997). [11] The composer specifies that in certain sections, Deep Listening Band is to process the sounds of the Joe McPhee Quartet (two winds, 'cello and percussion) through their EIS stations without themselves sounding. Of course, this harkens back to the earlier pre-1993 manifestation of centralized EIS control. The earlier compositions of Oliveros' Pauline's Solo and Gamper's David's Solo (both 1994), usually performed in succession, are a variation on this feature. In reality duets, each piece features the named performer sounding, with the other performer gradually adding additional EIS processing.

Recent Uses in Demonstration and Educational Settings

The Expanded Instrument System has proved itself in public demonstrations as well as in installations for study and exploration. When a musician, composer, or even musically untutored child has the opportunity to experience the immersive sound processing of the EIS, many seem to discover new worlds of listening and musical interaction. Although some of this effect may be inherent in playing into any delay line (the seduction of accompanying oneself is undeniable), the

transformations possible with the EIS are particularly fascinating. This no doubt is a result of its long development and refinement as a working musical instrument, grounded in Oliveros' aesthetic, and with input from a wide variety of composer/musicians.

Where appropriate and logistically possible, we sometimes have an "open mic" period of time before or after a concert. Children seem most interested and creative in publicly making sounds and hearing them return after having been processed by one or more of the performers. The immediate feedback of hearing your own delayed sound all around you, whether further transformed or not, can be exciting and enlightening. At one event, a jaw harpist filled the space with what developed into beautiful soulful music, far beyond idle noise making. At another, a child turned a spoken story into a drama with sound effects and music.

These "open mic" demonstrations are also opportunities to demystify the technological processes we are using in concert. We have always wanted performing with the EIS to be accessible to audiences as well as composers and musicians. There is no reason for this means of sound processing to be obscure or esoteric. We try to keep the technology as transparent as possible and familiarity is one part of that process. Oliveros' practice of Deep Listening, for which the Band is named, is inclusive and melds the performer with both the performance environment and the audience as fellow listeners. As Oliveros has written elsewhere:

The basis for all of my work as a composer/performer is a practice I created for my self which I call Deep Listening. It began with a meditation that came to me in 1957: "Listen to everything all the time and remind yourself when you are not listening." After 41 years of this practice I am still learning about listening.

In November, 1997, Gamper installed the Expanded Instrument System at Mills College (Oakland, CA) for the weekend "Composing a Career" conference sponsored by the Bay Area Women's Philharmonic and for the following week. During the conference, he demonstrated the EIS to small groups of composers and in the week following worked with three advanced music classes and many individual students and local composers. A number of interesting observations coalesced at this residency, including the following three.

Although everyone needs some period of instruction, musicians with even no experience with sound processing technology are able to learn to operate an EIS station. Once they reach some basic level of proficiency, it is fascinating to hear the varied ways they proceed to explore music making. Kurt Erickson, a composer/performer at Mills writes:
With some initial trepidation, I recently had the opportunity to work with the EIS and I must relate how quickly those intimidations vanished once I started working with it. The thing that surprised me the most about the system was its accessibility and opportunity for immediate artistic gratification. While I can claim no mastery of the system, I found myself achieving some very gratifying results within just minutes. In fact, some of the out-takes from my time on the system were later used as the basis for an electro-acoustic composition. To say that it made me rethink my approach to composition would not be an exaggeration. We are gratified that the EIS user interface adapts existing sound processing technology to enable even non-technologically oriented musicians and composers to discover many new creative expressive possibilities unanticipated by the authors.

A performer with the EIS is able to extend and expand musical materials, such that one can produce a lot of material from simple sound sources. One composer disclosed at the beginning of a session that due to a long illness he had not been able to practice an instrument for more than fifteen minutes. Gamper left him after the training period and returned an hour later to find him still playing. Fortunately, the appointment following his didn't appear and he could continue for another hour and a half. He was elated that he had been able to make music again for an extended time. He proposed and proved that the EIS could function as a sort of prosthesis.

One of Oliveros' interests in developing the EIS was the effect of multiple delays on tone quality, observing that as the delays pile up, a virtual acoustic space is created that colors the sound of the instrument differently. Another composer/performer, saxophonist John Ingle, writes:
I am a skeptic when it comes to electronic processing of the acoustic sound of my saxophone. While I am interested in electronic music, I have usually been disappointed in the sound quality when I have had my sound processed in a real-time performance situation. Because of my interest in resonance, the harmonic series, and difference tones, I was eager to test the Expanded Instrument System. As an avid improviser, I found the EIS

to be full of immediately gratifying musical possibilities, all in the "moment at hand" rather than through preconceived structures. In improvising with delay units, one must immediately deal with the preceding moment, or musical gesture. This can be a great tool for ear training, playing with a linear rhythmic pulse, and concentration. I think the EIS can be a powerful pedagogical tool for people of diverse musical backgrounds, from children to professional musicians. Because of the open ended nature of the system, different artists can naturally get widely diverse results. While I used it as a "partner" in improvisation, one could also develop highly sophisticated through-composed works for instrumentalists and the system.

These testimonials, along with our development of the new PCM 42 MIDI interface, have prompted us to implement a small permanent EIS installation at the new Studio at Deep Listening Space in Kingston, NY. Under development is a self guided tutorial to introduce composers and performers to its operation and functions. Also planned are improvements to the programming interface which would allow experienced users to experiment with designing their own modulation algorithms and modulation sequences which could be applied to appropriate control parameters. Many have expressed interest in such a facility, and we expect a wide variety of compositions and performances will come from it.

Further Expansion

Oliveros' 1995 article concluded with a list of areas of future EIS development. Some of them have been attained or superseded. This article will also end with a wish list for further development of the Expanded Instrument System:
*   There is much room for improving the foot pedal and switches as a performance controller. Gamper has experimented with a modification which add switching capabilities to the foot pedal. Bielecki is investigating instrument mounted controllers to allow free fingers to be used. *   The PCM 42 MIDI interface now encourages development of the
capability for a performer to record and play back sequences of controller movements.
*   Improve the physical set up of the system to simplify and speed installation. A plug and play EIS might be ideal. * Continue to improve the clarity of the user interface and

transparency of the technology.

References and Notes

1. The Expanded Instrument System is a project of the Pauline Oliveros Foundation and the name "Expanded Instrument System" is trademarked by the Pauline Oliveros Foundation, Inc.

2. Pauline Oliveros and Panaiotis, "Expanded Instrument System (EIS)," Proceedings of the International Computer Music Conference, (Montreal: 1991) pp. 404-407.

3. Pauline Oliveros, "Acoustic and Virtual Space as a Dynamic Element of Music," Leonardo Music Journal, Volume 5, 19-22 (1995).

4. Macintosh computers running Opcode's Max programming environment are used. Max allows us to quickly build displays for the performer as well as program higher level functions, such as modulation algorithms and complex multiple control outputs from a single controller.

5. The first sound processor is always a Lexicon PCM 42 digital delay. Other sound processors are Lexicon PCM 70 or 80 reverberation units and the Reson8 multiple DSP computer running a delay program. The single Reson8 is shared by all musicians through four channels AD/DA conversion. Other devices, such as an automated Mackie 1604 mixer and Niche ACM MIDI controlled amplifiers, provide for microphone preamplification, gain control and signal routing and mixing.

6. More technical information can be found on the EIS web site: <http://www.artswire.org/pof/EIShome.html>

7. For a description of the Lexicon PCM 42, see Oliveros' Leonardo article referred to in [3] above.

8. The LightningBox modulation algorithm was inspired by Oliveros' piece The Lightning Box, mentioned on page 21 of [3] above.

9. Oliveros' Epigraphs in the Time of AIDS (1994) and Fullman's TexasTravelTexture, (1994), comprise the CD Suspended Music (P0010) (Seattle, WA: Periplum, 1997).

10. An article inspired by the event by David Bernstein can be read at <http://www.mills.edu/LIFE/CCM/CCM_Archives.html> and a CD of excerpts is to be released by Music and Arts in 1998.

11. Premiered August 9, 1997 at the Lincoln Center Out of Doors Festival in New York City by Deep Listening Band and the Joe McPhee Quartet with Rachel Pollack reading from her text.

12. More information on Deep Listening can be found at <http://www.deeplistening.org>.

List of Illustrations:

1. Photo of Deep Listening Band performing with the Expanded Instrument System at The Kitchen, January 1995.

2. Screen shot of user interface.

3. Video still of The Kitchen site from the "Virtual Concert", April 6, 1996.

Discography of Recordings Using the Current Expanded Instrument System Configuration:

Deep Listening Band, Sanctuary (composed 1993 & 1994) (Mode 46) (New York: Mode Records, 1995).

Deep Listening Band, Tosca Salad (composed 1993-1995) (DL 3) (New York: Deep Listening, 1995).

Deep Listening Band and the Long String Instrument, Suspended Music (composed 1994) (P 0010) (Seattle, WA: Periplum, 1997).

Deep Listening Band and Guests, Non Stop Flight (composed 1996) (?????) (San Francisco, CA: Music and Arts, 1998?).

Pauline Oliveros, David Gamper and Guests, Starfish (composed 1994, 1995) (Mode ??) (New York: Mode Records, 1998?).

NB: The last two have unknown release dates, hopefully known by the time the article goes to press.

These CD's can be ordered from <http://www.deeplistening.org/dlc/21dlb.html>.