CULTURAL AND TECHNICAL PERSPECTIVES ON *WINTER LANDSCAPE*

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Winter Landscape is an interactive composition for erhu (Chinese two-stringed fiddle), flute, piano, and Max/MSP interactive computer music system. The total duration of the piece is approximately 15 minutes. *Winter Landscape* serves to demonstrate one particular approach to exploring the possibilities afforded in an interactive paradigm within a cross-cultural context. The work is intended to convey my personality and identity as a contemporary Chinese composer through diverse cultural and musical influences drawn to this particular piece while creating a balance between traditional and modern sounds.

The influences of Chinese philosophy (especially *Chán*) and the essence of Chinese traditional music play a prominent role as demonstrated in the formation of structures, expressions, and concept of *Yun* in the work; these influences also play a great role in determining the instrumentation and basic pitch structures of the work. However, this work is equally influenced by techniques and practices of modern Western classical music. These diverse influences hopefully have resulted in a unique work that truly does represent a cross-synthesis of these varying influences.

In *Winter Landscape*, the interaction that takes place between the computer and the live musician is intended to reveal the responsive human/machine relationships. The computer constantly shifts its roles as a musical instrument, conductor, performer, and improviser to facilitate the sonic realization of the solemn, nebulous, and peaceful nature of *Chán* philosophy, thus exploring the cultural and musical potentials; meanwhile, the design of algorithmic structures simulate the modeling of human performance, enabling the computer with intellectual ability and musical expressivity as a decision-maker, resembling its counterpart—the live performer.

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PART I:

CULTURAL AND TECHNICAL PERSPECTIVES ON *WINTER LANDSCAPE*

Introduction

A. An Overview of *Winter Landscape*: Hardware, Software, and Performance Space

Winter Landscape is an interactive composition for erhu (Chinese two-stringed fiddle), guzheng (Chinese zither), flute, and Max/MSP interactive computer music system. The composition includes alternate clarinet and piano parts in the event that erhu and guzheng performers are not available. The total duration of the piece is approximately 15 minutes.

Snow was chosen as the subject because the artistic concept that snow conveys reflects the Chinese philosophy of *Chán* (the Japanese pronunciation is *Zen*). The purity, cleanness, uniqueness (in shape), tranquility, and brightness of snow echoes the beauty of *Chán* philosophy—solemn, nebulous, elegant, and peaceful, as well as the essence of *Chán*—integrating "have" with "have not" (emptiness), and "motion" and "motionlessness." The ultimate goal of studying *Chán* is to attain the state of the unity between "universe" and "self" and perfect peace, or nirvana. As a result, the snowy landscape illustrates *Chán*'s spirit in many ways.

The three-movement piece, *Winter Landscape*, is intended to depict a Chinese snow scene accompanied by the composer's artistic conceptions of snow through music. Three movements, each based upon an ancient Chinese verse respectively, are titled: I)"清" (*A sparkle begins to fall…*), II) "舞" (*Little dances of snowflakes*), and III)"悠" (*Snow spell*). "清" delineates the smoky and foggy landscape created by the snow, "舞" emphasizes the floating motion of the snow to illustrate its ethereal beauty, and “悠” portrays a large picture of the “white world” covered by the snow. These three snow scenes will be presented in music through different textures, timbres, and temporalities.

The composition is intended to imitate Chinese painting (see Figures 1.1 and 1.2) in sound; thus, pentatonic scales, glissandi, and quotations from the Chinese guqin tune “White Snow” will be incorporated to evoke Chinese folklore as a context for the images of snow. Perfect fourths and fifths with chromatic intervals will be combined as the primary pitch content for this composition.

Figure 1.1 *Fishing in the Snow-River* by Fan ZhenDong

Figure 1.2 *Snow Rhyme* by LIU YanFeng

A MIDI footswitch will be controlled by the erhu player to direct the Max/MSP patches. Two microphones will be used to amplify and track the three instruments. In order to reduce potential tracking errors a music ensemble might produce, special microphones and filtering techniques will be used. The computer will not always process all three instruments at the same time, which will help reduce the acoustic interference during signal processing and maintain a sense of spatialization between the non-processed acoustic instruments and the processed sound. Amplitude-following, pitch/vibrato-tracking, and phrase-detecting, in addition to the MIDI footswitch, will control the interactive system pre-programmed in the Max/MSP software environment.

B. Formal Structure of *Winter Landscape*: An Introduction of the Formal Structure and the Musical Elements in Relation to Three Movements

The first movement of *Winter Landscape* is a through-composed movement that devolves gradually from the intrinsic ideas of the motif. Movement II is in the form of a rondo, illustrating the ethereal beauty of dancing snowflakes and Movement III is written in ternary form, in which the Recapitulation begins with the climatic point reached at m. 88 and restates the principal motif of the previous movements. As the movement progresses, the previous motifs reappear in a literal form and suggest a Recapitulation of the entire piece, outlining a large ternary design of A-B-A^1.

The beginning of the first movement is centered on the note B, from which this movement gradually unfolds and develops. In other words, Movement I is a continuous flow from the smallest musical unit, a single note, to the creation of textural density and timbral variety, which musically resembles the gradual accumulation of snowfall in the sky—from a single snowflake to a nebulous form of snowfall. Its continuous flow in music is realized through the free elaboration and expansion of the motif, the constant alterations of phrase lengths, and the tonal centers. The energy consistently accumulates and intensifies, propelling the music toward the climactic point of the movement in mm. 59-62. After a one-measure rest, the music flows forward, gradually releasing intensity and tension and eventually ending the movement with an extremely soft gesture: a harmonic note on the flute and a chord on the piano with the dynamic marking of *ppp*.

Movement II, “Little dances of snowflakes,” is written in the form of a rondo and is intended to depict the dancing character of the snowflakes. The recurring section (*rondo*) in this rondo form is a metaphor the circularity of the falling snow. By employing a quick change of the time signatures and unpredictable textural interactions among the voices, the Rondo section breaks the rhythmic and textural regularity and demonstrates a sporadic nature. To serve as a contrast, each Episode displays varying degrees of regularity or steadiness: *klangfarbenmelodie* in mm. 14-20 outlining a hidden and repetitive melody, the steady percussive beat produced on the piano in mm. 43-54, and the consistent rhythmic eighth-notes appearing in mm. 63-80.

Movement III is in a free ternary form (A-B-C). Section A contains three different musical ideas. The first idea, the Introduction, starts off as a fast succession of 16th notes in an ascending motion depicting a whirling snowfall. The second major musical idea begins from m. 18 as the piano plays trills in the low register while the flute plays the melody in a relatively free style, borrowing from a specific style called *Duo Ban* in Chinese opera. In *Duo Ban*, the Chinese *bangu* (the leading drum), combined with other small percussion instruments, plays regular and steady beats in a *presto* tempo while the voice creates a quite elaborate and free gesture floating on top of the beat. Here in the third movement, the piano is given the role of *ban gu* while the flute represents the vocal line. From m. 27, the piano and erhu become active in turn and gradually lead to interwoven textures. The third musical idea appears in m. 40, the echoing feature of the contrapuntal texture and the sporadic character being reminiscent of the motif of movement II. Section A ends at m. 46.

Comparing Section B (mm. 47-88) with Section A, it is apparent that they share the same thematic ideas and suggest a variation of a single melody. This movement reaches its climax at m. 88. After a few measures' sustained tremolo, it enters into section C. Section C appears as a simplified statement of section B with an emphasis of pitch cell [0, 2, 5]; moreover, as the first movement of this piece originates from the same three pitch classes, Section C, making a sudden return, functions as the Recapitulation of the whole piece by reiterating the principal motifs from the previous two movements. From a long-range formal design, this piece outlines a large form of A-B-A^1, providing a sense of circularity.

Studying the three movements of *Winter Landscape*, it is clear that tonal contrast and conflict, which is quite usual in European classical music, is intentionally avoided, except for the middle movement in which the alternations between Rondo and Episode demonstrate a certain degree of tonal contrast. Even though each movement falls into a certain category of traditional formal design, such as rondo or ternary, it illustrates a loose formal plan which is regulated by the progression of the melodic lines, not the harmonic or tonal function. Furthermore, the first movement shows a horizontal expansion of the initial melodic idea while the third movement exhibits a variation on the initial thematic idea. The concept of a *loose form* and the emphasis of melodic lines are inspired by the formal structure dominating Chinese traditional music. Further detailed discussions on the formal design of this piece can be found in Chapter 3 *Elements of Chinese Music and Their Applications in Winter Landscape*.

C. Historical Overview of Interactive Music: A Historical Overview of Interactive Performance Systems, Their Current Development and the Limitation of the Hardware and Software Available for Such Usage

During the early years of computer music, the considerably slow computational speed and high cost of the computers resulted in compositional activities and research on computer music existing exclusively at institutions that had adequate financial support and computing resources available. Given the slow processor speed and storage limitations of early computer music facilities, the composers could only work on a small portion of the sound at a time and then store the audio (and code) utilizing magnetic tape. The slow and arduous nature of early computer music made the realization of a live interactive music performance impossible (Dodge, 402).

This situation did not change until the mid 1970s when the microprocessor was developed. For the first time, digital signals could be calculated in real time and the sound-generating algorithms were manipulated in increasingly flexible and sophisticated ways. With the availability of the microprocessor and the ability for a computer to calculate samples in real time, a blooming market of commercial digital instruments as well as computer music software resulted. Commercial digital instruments are implemented in a traditional way: the live performer operates a single or a group of electronic musical instrument(s) by playing the notes as well as triggering a series of musical events that are pre-programmed by the performer or the composer. Historically, the widespread use of commercial instruments have occupied the computer music stage in significant roles; however, this is neither the interactive music the academic world refers to today, nor the interactive music which will be discussed in this paper.

Generally speaking, interactive music reveals two-way communications generated between musician(s) and musician(s), musician(s) and the audience(s), and musician(s) and computer(s), ALL in real time. Based upon this definition, to a certain extent all live performances—whether or not computers are involved—are interactive music. However, interactive music as discussed in this paper is limited to paradigms that include computer involvement, which, according to composer Todd Winkler (2001), is "a music composition or improvisation where software interprets a live performance to affect music generated or modified by computers." He also suggests examining instances of musician-to-musician interaction as potential models for computer to musician interaction.

1. Interactive Performance Systems

Within this context, early interactive computer music written for live performance involves live instrumentalists playing a traditionally notated score or improvising on their instruments along with a pre-recorded sound track. Originally, the sound track was stored on magnetic tape. As the computer became faster, the performers were able to play with parts synthesized in real time (Dodge, 412). In either instance these performances represented a one-way communication: i.e., the performers listen to the fixed parts and determine what (tempo/volume) they should play in order to synchronize with the synthesized sounds. In recent years as the technology has advanced, it has become possible for the performer and computer to have conversations with each other in real time based upon the acoustic signals produced.

A standard interactive performance system consists of two components: hardware and software. In addition to the computer and acoustic instruments/voices, the use of microphone, audio interface and digital mixing board are integrated to provide an environment for the two-way dialogues. The microphone transmits the atmospheric pressure into electrical signals that are subjected to real-time analysis. The electrical signals are then converted to binary digits through the digital audio interface in order to be manipulated by the software. The mixing board is used to control the input/output signal balance as well as the signal paths. A MIDI pedal or other type of controller interface that can be used to provide additional performer input is optional depending on composer's preference.

The software used in interactive compositions has two primary functions: analysis and synthesis. The digital signals are first analyzed by the software to detect individual parameter data such as frequency, amplitude, envelope, overtone components, pitch/rhythmic patterns, etc. The parameters acquired from the analysis process can be used to trigger a series of events programmed in the computer and/or mapped to control other aspects of the computer-generated score (i.e. create certain digital sound effects or impose the time-varying envelope on another sound by means of modulation). In the simplest form, the computer "listens" to the live performer and interacts with him/her in real time, working as an additional live performer.

The software widely used for interactive music performance includes Pd (Pure Data), Max/MSP, SuperCollider, and Ableton Live. Each software platform has its unique advantages, and its large user base of programmers, composers, performers, researchers, and artists.

a. Max/MSP vs. Pd

Since Max/MSP and Pd are both designed and developed by Miller Puckette, despite a number of fundamental differences they share significant similarities: both of them are graphical programming environments for interactive computer music composition as well as multimedia work presentation; and the design of each is an example of Dataflow in which the objects are linked (or patched) together to facilitate the flow of the control and audio. Like Max/MSP, Pd has a modular code base of externals or objects which are formed as building blocks, endowing the program the capability of being extensible through a public API, as well as encouraging the programmers to contribute their own module design or signal flow to the existing patches, either in the C programming language or in another programming environment, such as Python, Ruby, or Scheme, among others. (http://en.wikipedia.org/wiki/Pure_Data)

Unlike the original version of Max, however, Pd, from the very beginning, was designed to manipulate control-rate and audio processing on the host CPU, rather than unloading the signal processing to a DSP board. To a certain degree, Pd code provides the basis for MSP extension to the Max language to implement audio processing. In addition, Pd is designed to enable live collaboration across networks or via the internet, allowing musicians on different corners of the globe to be able to create and perform music together in real time with the aid of a LAN connection.

b. SuperCollider

SuperCollider, originally released by James McCartney in 1996, is a programming environment designed for real-time audio synthesis and algorithmic composition. The joint efforts of numerous programmers and artists have made this software an efficient and expressive programming language that provides an integrated platform for acoustic research, algorithmic composition, and interactive music performances.

The programming environment of SuperCollider combines the object-oriented structure (Smalltalk) and functional programming language with a C family syntax. More specifically, it means that the programmers need to define not only the data type of a data structure (units of data: information which the instructions operates on), but also the types of functions (units of code: sequences of computer instructions) that can be applied to the data structure. Traditionally, code and data have been kept apart.

Due to its object-oriented structure, SuperCollider offers an unrivaled sound programming environment that can provide infinite possibilities for creating and processing high levels of sonic complexity. Moreover, it forces the programmer to understand what he/she is doing with those codes, which puts the programmer in a self-explanatory position to debug, maintain, and extend the programs. However, because of its object-oriented nature, its advantage has the potential to be a disadvantage in that it is much harder for inexperienced musicians to grasp and master this language, compared with Max/MSP or Pd.

c. Ableton Live

Ableton Live is a professional loop-based software music sequencer by Ableton. Written in C^{++}, Live is designed for use in live performances as well as for music production. Ableton Live is comprised of two major functions: 1) a tool for music composition and mixing like other traditional sequencers but with more flexibility and power; 2) an extended capability for live interactive performance. Its powerful composing and arranging functions with built-in instruments and effects and uninterrupted creative flow, favored by numerous musicians and DJs, differentiate it from the other software mentioned above. Moreover, with the advent of version 8, Ableton Live introduced a series of new features, including an integrated Max/MSP platform, internet collaboration possibilities, and many new effects and workflow improvements. Max for Live, as an extension for Ableton Live, successfully integrates Max/MSP into Live's workflow and user interface, which gives Live users the power and potential to create unique instruments, effects, and extensions from scratch according to personal needs. The integration of Max and Live enables users to manage Max devices, save presets or use automation and mapping just as in managing Ableton devices. The combined ability of a music sequencer and Max/MSP programming environment guarantees Ableton Live a large potential userbase in the future.

2. Diverse Approaches to Interactive Music Composition: Basic Concepts of Interactive Performance with Reference to Ideas from Miller Puckett, Robert Rowe, and Cort Lippe

Score following, initiated by Barry Vercoe and others, including Miller Puckett, is probably the most widely employed approach in interactive composition systems. In *score following* mode, the computer analyzes the performer's input data, triggers a series of pre-programmed events, and responds to the sounds created by the live performer by synthesizing a variety of parameters. In other words, the computer advances a pre-composed score stored in its memory and makes "temporal alignment of its score with the score being played by the performer" (Dodge, 415).

In *score following* mode, pattern-matching algorithms are utilized to detect the current position of the performance. The algorithms detect "the sequences of onset times, pitch patterns, or both" (Dodge) and compare the pitch patterns generated by the live performers with the ones pre-programmed and stored in the computer's score. A match between the live performer and the computer's score triggers one or a series of musical events. Depending on the different instruments, various pattern-matching methods are applied. For instance, detecting the pitch pattern of a polyphonic instrument or a percussive instrument might be challenging; a phrase-detector or attack-detector might be more appropriate in such cases. Therefore, the composer may choose to primarily detect the pattern of onsets (rhythm) and use pitch-detection as a complementary device.

Another notable interactive performance system, known as Cypher, was developed by Robert Rowe. Three related functions are integrated in this system: listening, composing, and playing. The first function, *listening*, is designed to capture the musical parameters generated by the live performer through the reading of the incoming stream of MIDI data. The computer listens to and analyzes these data for such categories as tempo, velocity, pitch, register, harmony, and density. "It sorts the lines into phrases and then analyzes the phrases to deliver a high level of information to the other system functions." (Dodge)

The second function, *composing,* is realized in several different ways:

i) The input data is used to trigger a specific musical event, which in turn is synchronized with the temporal pattern of the input.

ii) The initial input data is modified based upon classical composition tradition, such as transposition, fragmentation, arpeggiation, motivic transformation, and/or looping a specified portion of the input.

iii) The input parameters are analyzed and used to activate a compositional algorithm. The algorithm takes the form of a controlled random process, to a certain extent resembling controlled improvisation, then synthesized into live sounds.

Composer Cort Lippe is one of the most active real-time computer music composers today; furthermore, he has published numerous articles discussing the development of interactive music performance systems and posing technical and aesthetic problems of computer music. Examination of his music and articles demonstrates a significant emphasis on the relationship between the performer and the machine. The interactivity, the essence constructing the work, is carefully planned, designed, and realized in his works. Quoting Lippe's own words: "Fortunately, a composer can assign a variety of roles to a computer in an interactive music environment. The computer can be given the role of instrument, performer, conductor, and/or composer. These roles can exist simultaneously and/or change continually, and it is not necessary to conceive of this continuum horizontally." (Lippe, 2002)

In a typical interactive music performance system, the live sounds generated by the performer are tracked and analyzed by various detectors such as envelope-trackers and FFT[1]-based analyzers and transformed by utilizing digital signal processors such as time-delay based filters and flangers. The computer output processes samples to add to the live performance or synthesize sound in real time. More importantly, the computer "listens" to the live performer's sound, responds accordingly, and quickly switches its roles as an instrument, performer, conductor, and/or composer. Lippe makes sophisticated and versatile use of the information the

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[1] Fast Fourier Transform. Curtis Roads, *The Computer Music Tutorial* (Ma.: Massachusetts Institute of Technology, 1996) 1073-1112.

computer captures to create a dynamic relationship between performer, musical material, and the computer.

For instance, pitch tracking, used to determine the stability of the pitch in a music flow and capture specific note at a time, is expanded by Lippe to distinguish *portamento*, *glissando*, *trills*, and *tremolo*; traditional envelope following is improved to detect articulations such as *flutter-tongue*, *staccato*, *legato*, *crescendo*, etc. More complex and thoughtful event detections, such as the tracking of the inharmonic/harmonic ratios and their respective energies for multiphonics and *sul ponticello* recognition and the combined detection of pitch, amplitude, and spectral information for subtle change detection, are created at different levels (http://digitalmusics.dartmouth.edu/~wowem/interviews/lippe.html). Lippe contributes the numerous possibilities for real-time decision-making and rich controls for the interactive performance and leaves the creative decisions to the individual composer.

The dynamic relationship between performer, musical material, and the computer revealed in Lippe's works is demonstrated as an intimate and responsive relationship in which musical expression takes precedence. He strives for an ideal interactive environment where "compositions can be fine-tuned to individual performing characteristics of different musicians, performers and computers can interact more intimately, and performers can readily sense consequences of their performance and their musical interpretation." (http://digitalmusics.dartmouth.edu/~wowem/interviews/lippe.html)

3. The Limitations and Problems of Current Interactive Music Systems

a. Accuracy and Reliability of Real-time Detecting

In regard to the limitations of current interactive music system, the accuracy and reliability of real-time detecting on particular musical instruments still needs improvement. Since different instruments have unique physical characteristics, it is challenging for composers to design universal detectors to be applied in every musical instrument. For instance, many folk instruments are not constructed on well-tempered tuning; therefore, it is sometimes difficult for them to fit into a pitch detector designed upon a western musical instrument's analysis data. Another example is the accuracy of the attack-detector. For example, the high pitches produced on the Chinese instrument erhu, perceived as loud dynamic, display rather weak amplitudes according to MSP; or otherwise stated, the amplitude response on the erhu has a significant discrepancy between the physical production and aural perception. Moreover, even different erhus have different attack responses. Accurately capturing the unusual instruments' attack parameter and stabilizing the data becomes one of the challenging topics for an interactive musical system. Fortunately, this is expected to improve in the near future.

b. Error Re-directing Method

The second problem in the development of interactive performance is how to treat and direct the errors (such as the wrong detection, triggering, etc.) made either by the performer or the computer, and how to make a recovery plan for the errors so that the performer and computer can catch up with each other and return from the digression (Dodge, 416). Due to the unpredictable factors during the interactive performances caused by the instrument, performer, or the computer's instability or inconsistency, it is quite typical that missed detections or wrong triggering may occur during the performance. For programmers, designing several detouring or recovery plans is a way to remedy the mistakes so that the computer's performance does not become completely lost due to a fault condition. However, this kind of remedy can be implemented only to a certain degree: the computer sometimes cannot give a satisfying response within the parameters of the live performance. Therefore, a more "intelligent" and "humanistic" remedy is desired in order to provide a much more stable performance.

c. Aesthetic Problem for Interactive Performance Systems

The third problem which does not rely on either hardware or software limitations is an aesthetic problem for interactive performance systems. Normally, interactive music takes much more time for composers to compose and to program, since it requires an interactive music composer to work as a musician, as well as a programmer/mathematician. The conflict between the programming techniques and the musicality is a significant factor for the composer to consider. Most of the interactive compositions to date have displayed an emphasis either on the musical side or the technical side—few compositions demonstrated a perfect blend of techniques and musicality. As a result, the degree of interaction between the musician and the computer (musicality vs. mechanism) is a problem the composer must ponder.

d. Expansion of the Roles of the Computer

The fourth problem is how to expand the roles of the computer and the sonic possibilities of the interactive computer system. Theoretically, software such as Max/MSP can provide infinite sonic possibilities to the composers; nonetheless, most of the interactive music sounds quite similar. Generally speaking, the computer is treated as an effect module, a musical instrument, or a virtual improviser. Most of the signal processing algorithms (such as reverb, flanging, filtering), FFT analysis-resynthesis, and envelope-tracking make use of delayed copies of signals for their real-time computation. Subsequently, the performer's live sound is used as the input for the computer's transformational process (Lippe, 116), which forms a relationship of *call and response* (performer/machine). This situation can hardly be reversed, for the real instrument has rather limited ability to transform its sonic nature except for the traditional musical techniques such as augmentation, diminution, transposition, inversion, retrograde, etc.

As the name "interactive music" implies, interaction between/among the musical instruments should be one of the most important factors to evaluate an interactive performance: neither a passive effect generator nor an overly active musical generator/improviser is convincing to the audience. The performer is a live musician while the computer is a virtual musician: an overly active performance on the computer would provide a sense of the computer leading without listening for the former, while an overly passive performance of the computer would provide a sense of the computer passively responding in the latter. The overwhelming use of time-delay based signal processing and the *call and response* relationship between the performer and machine lead the interactive music to a bottleneck and limit the development of interactive performance system. Hence, a computer with more independence and spontaneity and more unique functionality is urgently needed to facilitate the interactivity of a real-time computer music performance system.

e. Rehearsal and Notation Problems

It is apparent that there are more limitations or problems existing in current interactive music performance systems than previously mentioned. For instance, a crucial problem composers often encounter includes rehearsal limitations. It is common for composers to find that the system on which the work will be performed is not set up until just prior to the live performance; this gives the composer very little time to test the setup and adjust the levels. For example, the unpredictability and instability of an interactive system setup might simply be caused by the acoustic performance space being different than the space in which the work was composed and tested. This often results in the detectors not working properly (pitch-detector, attack-detector, etc.). Complex interactive requirements normally compound this problem.

Finally, notating the interactive component in the musical score is also a significant problem for interactive music composers: too much or too little information appearing on the music score might cause problems for a live performance. As a solution, some composers create two scores: a performance score which only includes the necessary information for the performer and is similar to the part in a traditional ensemble score, and a master score which records necessary details for composers throughout their compositional procedures. It has been shown that the use of two scores provides a successful solution for notational problems in interactive music performance; however, the imprecision and uncertainty in notation calls for a more sophisticated and standardized practice of notation developed through interactive music composers’ continuing compositional works.

Elements of Chinese Philosophy *Chán* and Their Applications in *Winter Landscape*

A. History and Essence of Chinese Philosophy *Chán*

1. A Brief History of *Chán*

*Chán***,** an abbreviation of the Chinese transliteration of the Sanskrit term *Dhyāna*, means "quiet contemplation." (Hsing Yun) Tracing the origination of *Chán*, legend has it that in ancient India during an assembly, the Buddha picked up a flower and showed it to the assembly without saying a single word. No disciples in the assembly understand the meaning of Buddha's conduct, except for Mahakasyapa, who understood the true indescribable meaning of the flower and smiled. Thus, *Chán* was imparted without standing upon any kind of spoken or written language. It de-emphasizes both theoretical knowledge and the study of religious texts, laying emphasis on the direct realization and the transmission from mind to mind. *Chán* was later introduced into China and flourished during the time of the Sixth Patriarch, Huineng, who developed *Chán* into five schools and made it the mainstream of Chinese Buddhism. From China, *Chán* subsequently spread to other Asian countries, such as Korea, Japan, and Vietnam.

2. The Essence of *Chán*

a. Have and Have Not

It is widely believed that all existence in this world can be differentiated by its nature and/or name and duality and interchangeability are intrinsic qualities of all things. *Have* and *have not*, in ordinary people's minds, are two opposing concepts and cannot coexist—if one *has*, he or she cannot also be in the state of *not having* and vice versa. Nonetheless, in the *Chán* concept of the world, "no existence can be divided into distinct halves" (Hsing Yun). *Chán* masters mentally dispel the dividing line between *have* and *have not*, transcending the ordinary concepts of *have* and *have not* to a higher level. For them, the ultimate goal is to embrace both of these seemingly contrasting concepts simultaneously, and integrate *have* with emptiness (*sunyata*). Only when one can transcend *have* and *have not* does he realize the ultimate *Chán* mind and experience the wondrous truth of *Chán*.

b. Motion and Motionlessness

Three Dharma Seals are the basic doctrine of Buddhism. They specify that: 1) "All samskaras (composite things) are impermanent;" 2) "All dharmas (ideal truth as set forth in the teaching of Buddha) do not have a substantial self;" and 3) "Nirvana (personal liberation) is perfect peace." (Hsing Yun) From the doctrine it can be perceived that one of the important and ultimate goals for *Chán* practitioners is to reach the state of perfect peace, *nirvana*.

This "perfect peace" is not equated with the concept of *motionlessness*. In the Chinese philosophy of *Chán*, any object which is either in motion or motionless is still sensed and distinguished by the ordinary mind and not by the phenomena themselves (which do not make the distinction of being in motion or being motionless). This subjective distinction is caused by human delusion in perception. If people can free themselves from their subjective judgment, their minds would be at peace and the world would be in harmony. The ordinary mind makes judgments but the transcendent mind does not, and therein lies the difference in perception.

Chán masters' cognition on the world does not linger on the superficial appearance of phenomena; instead, they look within themselves. In their conception, *motion* and *motionlessness* are united as one. As aforementioned, the differentiation between being in motion or being motionless is generated by people's minds—due to the stirring of their thoughts, not due to the phenomena themselves. If their minds are tranquil, they will be able to integrate one state into another and perceive the interchangeability of the phenomena; on the contrary, if their minds are stirred, they separate and distinguish between others and themselves. As a result, the only method to unite *motion* and *motionlessness* is to eliminate all the discriminations arising out of perceived differences, which leads the way to the attainment of perfect peace.

c. Purity and Impurity

The distinction between *purity* and *impurity*, or prettiness and ugliness, is not made by nature itself; instead, like the perception of *motion* and *motionlessness*, it is people's subjective likes and dislikes (judgments) that make the distinction. It says in the *Vimalakirti Sutra*, "When one's mind is pure, the land will be pure." According to *Chán* masters, the subjective perception of the world is caused by the "five dusts"—perception by the five senses—which prevent the pure nature of all dharmas from being seen. The minds of realized *Chán* masters are pure and unobstructed. They can see the real nature of all the things. To them, there is no distinction between good and evil, beauty and ugliness, or right and wrong. The world, perceived as impure and corrupt by the ordinary people, is seen as a pure Buddha Land (Hsing Yun).

In conclusion, the dichotomies—*have* and *have not*, *motion* and *motionlessness*, and *purity* and *impurity*—often distinguished by ordinary people as pairs of opposing concepts, are united as being one state by *Chán* masters. Through the meditative concentration of *Chán*, all dichotomies are ultimately freed and unified.

B. Artistic Conception of *Chán*

1. The Concept of *Essence* and *Phenomena* in *Chán*

Chán has broadly been employed in various Chinese art forms, such as music, painting, poetry, and garden design. It has influenced the artists' ways of viewing the world, as well as the ways of conveying their artistic ideas through the art forms.

Describing *Chán* is not easy, for *Chán* can neither be talked about nor expressed in words; rather, it is a state of mind that can only be experienced and perceived. The application of artistic conceptions revealed in *Chán* devolves from the principles of *Chán*: mindful acceptance of the present moment, spontaneous action, and the state of the united "universe" and "self." In most cases, all the *Chán*-involved arts have the nature and functions of meditation and contemplation and frequently include the essence of *have* and *have not* into their artistic practice.

A well-known analogy made by Dharma in regard to the integration of *have* and *have not* is salty water: the water is not the salt and the salt is not the water—they are two distinct objects; however, the fact is that every single drop of the water is infused with the salt and every grain of the salt is dissolved into the water. In the context of artistic conception, the "have" (water), belonging to the physical substance—the tangible matter of which a thing consists—is analogous to the physical existence of an object appearing in a painting, a word in poetry, or a note (or the sound) in music. Conversely, the "have not" (salty taste), belonging to the sensual world—relating to any of the senses or sense organs—is intangible and amorphous, which can be associated with the artistic conceptions which the painting, poetry, or music attempt to convey; or the conceptions the reader, viewer, or the listener obtains through appreciating an art work.

性相 (xing xiang) is terminology derived from Buddhism. Through literal translation, it means the two layers—*essence* (xing) and *phenomena* or *outward appearance* (xiang)—of an object, which is a further expansion of the example of salty water described in the previous paragraph. For instance, music is often described as an artistic form. Here, the word "artistic" represents the *essence*, belonging to the sensual (or spiritual) level while the word "form" is related to the tangibility of music, *phenomena*. Therefore, "have" and "have not," depending on their use in various contexts, are often intertwined with each other and appear as different forms of expression at different levels, such as spirit and material, content and form, essence and phenomena, artistic conception and physical existence, etc. (Yun Xue Tang, web source).

2. Two Different Levels of Artistic Conception

a. Artistic Conception on the Objective (Surface) Level

Artistic conceptions conveyed in Chinese music can be explained on two different levels: the objective level and the emotional level. The objective level, usually focusing on the faithful reproduction of the nature and outward appearance of an object, aims at likeness in form or appearance. For instance, the slow tempo, prolonged note duration, lightness of touch, combined with transparent and flowing harmonics, delineates the emptiness of the wild desert, as seen in the Chinese guqin piece *Ping Sha Luo Yan* (“Wild Geese Descending on the Sandbank”). Another example can be found in *Feng Lei Yin* (“Prelude of Wind and Thunder”) in which the sounds of the wind, the rain, and the thunder are intentionally imitated. A simple portrayal of the natural world, considered as *onomatopoeia* in music, purposely creates a moving illusion of the actual object, resulting in an imaginary, invisible, and abstract atmosphere. This kind of austere reproduction or suggestion, even though carrying an artistic conception, belongs to the very surface level, the objective level.

b. Artistic Conception on the Emotional Level

In this mode, the typical *Chán* pieces are characterized as being placid, peaceful, light, delicate, self-controlled, introspective, and introverted. Self-control is considered a virtue, as described in Buddhism. People should not be influenced by the *eight winds* (the winds of the eight directions): praise, ridicule, suffering, happiness, benefit, destruction, gain, and loss. At this level, personal expressions are rationally controlled. However as *Chán* philosophy states, the lack of secular emotion does not necessarily means the lack of sacred emotion. Applied in this particular context, it means that the self-control does not necessarily signify the lack of emotion or expression. Musical experiences immersed within philosophical contemplation contains profound care and concerns: such as the elegant and impartial bearing conveyed in guqin tune *Mei Hua San Nong* (“Three Variations on ‘Plum Blossom’”), the awe-inspiring righteousness conveyed in *Li Sao* (“Woes of Departure”), the voice that advocates social transformation in *Feng Lei Yin* (“Prelude of Wind and Thunder”), and the praises of nature’s infinite creativity, as well as of the unity between the sluggish trickle of water and the flowing rivers, or the unity between the limited life and the unlimited future expressed in *Liu Shui* ("Flowing Water"). (Yun Xue Tang, web source) The humanistic concerns and keen insights revealed in such musical works resonate with the composers' world-view of establishing a harmonious relationship between nature and man. For this very reason, the artistic conceptions in those pieces are created and portrayed on a higher level, the emotional level.

C. The Applications of *Chán* Philosophy in *Winter Landscape*

Snow, chosen as the subject for this composition, corresponds to a great extent with several principles of *Chán,* as it naturally integrates and unifies the dichotomies such as *have* and *have not*, *motion* and *motionless*, and displays the spirit of non-discrimination.

- Unification of *have* and *have not*: the snowflake is tangible and visible when it lands on a person; however, upon reaching a certain temperature in a transient period of time, it melts and disappears. The interchangeability of the snow obscures the distinction between *have* and *have not*, manifesting a perfect integration of *have* with emptiness.

- Snow falls slowly from the sky due to its light weight. When viewed from a great distance the snowflakes seem to linger in the air and be motionless, like a static picture. The integration of *motion* and *motionlessness* in snow's movement calls for a tranquil mind that is capable of integrating one state into another, and ultimately facilitates the attainment of a spiritual state—that of perfect peace.

- The concept of acceptance: snowfall covers evenly the surface of the land: it settles on top of the rocks, into the river, on the mountain, no matter the landform or the shape of the terrain. It is profound and broad-hearted, and enshrouds the entire world without any discrimination, which stands alone as a perfect example of a state of the united "universe" and "self".

- The nature and quality of white snow purifies people's minds. Its lightness, transparency, elegance, motionlessness, and pure whiteness are often associated with the words such as solemn, nebulous, elegant, and peaceful, echoing the beauty of *Chán*. Snow thus becomes a favorite subject and is applied by a large number of *Chán* artists into their artworks. Moreover, the white world covered by the snow, to a certain extent, is analogous to the Pure Land in Buddhism, a paradise in which one can attain final Enlightenment.

As mentioned earlier in this Chapter, *essence* (mind) and *outer appearance* (phenomena) are two different layers embodied in *Chán* music. *Outer appearance* is the layer representing the objective level of the artistic conception while *essence* is referred to as the sensual or spiritual level. It is apparent that without *form*, *mind* cannot be expressed; without *mind*, *form* cannot be made manifest. In *Winter Landscape*, these two layers are carefully designed and conveyed. Specifically, the sporadic character displayed in the beginning of the second movement seems to delineate and imitate the dancing posture of the little snowflakes; the gradual accumulation of notes and texture in the first movement resembles the accumulation from a single snowflake to a nebulous cluster of snowfall. These kinds of literal imitations of the natural phenomena perceptibly belong to the surface level of the artistic conception due to the direct portrayal of snow's physical form. However, beyond this level, the piece also expresses the composer's admiration and appreciation for the elegance and impartial nature of the snow, and even more, for the beauty of nature. The underlying praise and veneration carried through the piece, from a profound perspective, communicates the artistic conception on the emotional level.

Another important concept employed in *Winter Landscape* is *Yun*. *Yun*, which is difficult to explain in words, is an artistic perception that to a certain degree is correlated with *Chán* philosophy. *Yun* puts great emphasis on vagueness, implicitness, and silence, leaving space for the listener's perception, imagination, and enlightenment, and ultimately evoking a state of the integration of the sound and the imagination.

More specifically, the silence and the discontinuity between musical note events are not equal to emptiness; instead, it carries over the energy from the preceding event to the next one and leaves space for the listener to absorb the sound as well as feel the sound. In this way, the listener completes a perceptual transformation from the physical level (the sound) to the spiritual level (the feeling). In other words, *Yun* could be understood as a kind of energy flow that is derived from the vitality of each musical event and ultimately resonates with the listener's spiritual world. Therefore, it is evident that the concept of *Yun* is closely related to *Chán* in regard to the emphasis on spiritual perception, as well as the transformation from a surface level (the physical sound) to an emotional level (*Yun*). Since *Yun* is also one of the most important elements governing Chinese traditional music, an in-depth investigation will be conducted in the next chapter: Elements of Chinese Music and Their Applications in *Winter Landscape*.

Winter Landscape, seemingly a depiction of the natural world, is yet a portrayal of nature on a spiritual level. Influenced by *Chán*, it intends to embrace spiritual enlightenment with natural phenomena by the means of embodying the boundless philosophical thinking within the limited form of music.

Elements of Chinese Music and Their Applications in *Winter Landscape*

A. Elements and Essence of Chinese Music: Forms of Structure and Expression in Chinese Music

The history of Chinese traditional music parallels the merging of the ideologies of Chinese philosophies, especially Confucianism and Daoism. The philosophical ideas represented in these two philosophies, such as the unity of the beautiful and the good in Confucianism, and the unity of feeling and setting in both Daoism and Buddhism, have significantly influenced the construction and the formation of expressions in Chinese traditional music (Wang, 3).

For instance, the concept of a loosely formed non-functional structure, a structural system of *variations on a single tune* is, generally, the musical product of Chinese philosophies. Furthermore, the aesthetic conception of the unity of the beautiful and the good has influenced the instrumentation of Chinese traditional music. Vocal music, considered as the purest sound, has dominated Chinese music history for a long time; instrumental music often has symbolic and metaphorical meanings. In addition, the philosophical concept of the blending of feeling and setting in Buddhism and Daoism has made the natural world a favorite subject for Chinese composers and also imbued Chinese traditional instrumental music with a unique form of expression—soliloquy and self-entertainment. The emphasis on illusion and implication in Chinese music echoes the blending of feeling and setting as well, which is similar to the discussion of the two levels of artistic conceptions of *Chán* as discussed in the previous Chapter.

The formation of structures and expressions in Chinese traditional music, nurtured by Chinese philosophies, have become the quintessence of Chinese music that provide for rich compositional resources and infinite possibilities for Chinese composers. The inspirations in *Winter Landscape* drawn from Chinese traditional music will be discussed in the following sections.

1. Formation of Structures: An Emphasis on *Line*

Chinese traditional music, despite a de-emphasis on the concepts of harmony and counterpoint, is filled with the flexible and rich techniques of *modulations* and *change of modes* (宫调理论). In European classical music, *modulation* and *change of modes* are associated both with the re-ordering of the pitch-classes and the change of the internal harmonic structure. Conversely, for Chinese traditional music, only theory is established upon pitch content, resulting in musical forms characterized by non-functional structure and a structural system of *variations on a single tune*.

From the perspective of the musical structure, it is apparent that in western music the melodic contour is inseparable from the harmonic and contrapuntal components—the melody interweaves with harmony and counterpoint to convey the musical ideas. In contrast, the melody in Chinese traditional music has significant independence, representing the *entity* of the music, and sometimes it's *entirety*. Quite often the alteration of the melodic construction even reflects a change of musical systems. The *qu pai* (*Named Tune*, a fixed melody used in traditional Chinese music) and *ban qiang* (a structural style based on a complex melodic and rhythmic motivic system) in Chinese music reflect this idea: the melody-oriented musical structure. Even though there are certain types of chamber music existing in Chinese traditional music, such as the accompanying instruments in Chinese operas and Chinese orchestra, the compositional use of orchestration is largely based upon the leading melody, which is why heterophony has become the dominant texture in most Chinese traditional music. The famous musicologist LI Xi'An referred to this kind of musical orchestration as the three-dimensioning of lines. It is fair to say that Chinese traditional music, to a great extent, reflects linear thinking.

Chinese ancient philosophies, although profound in content, lack the precision of logic and the rigor of logical reasoning; they seek philosophical "truth" through pragmatic experiences from society while de-emphasizing the establishment of an abstract theoretical system through inference and analytical thinking. Often in Chinese culture perceptual knowledge is more important than rational knowledge, experience is more important than science, and intuition is more important than logic. The de-emphasis on inference and analytical thinking has inevitably influenced Chinese musicians' thinking and led to the lack of rational thinking in Chinese traditional music.

For instance, the Chinese tuning system historically had a relatively sophisticated development, testimony to China's potential and ability in mathematics and logic. Given this, one wonders why this did not lead to the development of a more sophisticated theory in acoustic science and a series of musical theories on harmony and counterpoint, as in western music? The reason might be traced to the humanistic concept of people-oriented, an ideology that has been dominant in traditional Chinese culture for centuries. Artistic morphology is inseparable from the cultural soil on which the arts rely for existence and the cultural conceptions that underpin it. Thus, linear thinking permeates not only musical thinking but is also reflected in other Chinese traditional art forms (Wang, 22).

2. Formation of Expressions

In Chinese literature and arts, feeling or emotion is the ultimate goal for the artists. Unlike most western arts, Chinese arts de-emphasize the direct reproduction of the object while emphasizing an exaggeration of the artist's emotions. For example, line and color—the devices usually used to portray an object in western painting—are embodied with symbolic meaning in Chinese painting, thereby becoming a manifestation of emotion.

This concentration on emotion is also reflected in Chinese traditional music and is closely correlated with the characteristics of the ideas and structural patterns. For instance, the three-dimensional thinking prevalent in the western world is firmly associated with scientific logic. On the contrary, the linear thinking method in Chinese culture, irrelevant to any scientific structure, concentrates on the natural flow of emotions. Therefore, the establishment, the development, and the release of conflict and contrast in European classical music are all conveyed through a logical flow, while in Chinese traditional music the formal structures are often organized by the means of *unifying the variety*. As a result, the typical formal design of Chinese traditional music, a structure of free—slow—medium—fast—free, corresponds to the natural development of human emotions. (Wang, 23) This typical structural design is widely utilized in Chinese traditional operas in order to portray the natural development of the characters. The principle of this formal design implies integration and naturalness. Applied in the context of the natural development of emotions, the design of this form can be understood as a series of gradually- and naturally-developed emotional stages, including all different types and stages of emotional development; or to say, complete emotional growth.

Historically, Chinese culture has put an emphasis on the significance of mind. Many scholars consider Chinese culture to be a culture of mind. This *culture of mind* signifies internal transcendence, putting an emphasis on the exercise of self-control through mind, not through external society or some natural force; in other words, an ability to grasp cultural forms through subjective consciousness. The emphasis on *mind* has wide applications in Chinese traditional music as well. For example, the illusive and empty character featured in Chinese guqin music is illusive or empty only on the formal level, and calls for the mind to fill up the content and make the music complete. Here, emptiness itself does not mean nothingness; it is carefully designed to reserve adequate space for the mind to fill in.

The emphasis on emotion and mind, in the final analysis, is indeed an emphasis on people because emphasizing the functionality of mind must emphasize the origin of mind (people), as well as the key role of people in the universe. This dominant tendency in Chinese culture has nurtured a *people-oriented* ideology in musical expression. For this reason, the emphasis of emotion and mind in Chinese culture, permeated with Daoism's *nature view*, is a reflection of the humanistic spirit of Chinese culture and a product of the merging of the ideologies of Confucianism and Daoism.

3. The Concept of *Yun* in Chinese Traditional Music

Yun, frequently associated with Chinese traditional music, is somewhat difficult to explain. In this sense it resembles the artistic concept of *Chán* that can neither be talked about nor expressed in words; rather, it is a state of mind and can only be experienced and felt.

Yun is a concept associated with vagueness and implication. Unlike western music which normally utilizes dense texture and colorful orchestration to directly depict the atmosphere or convey the emotions, Chinese traditional music takes a different approach by putting an emphasis on the vagueness, implication, or implicitness of the sounds. Or in other words, the view is held that realism (the setting) and perception (the feeling) should be combined together and that emotion should transcend self and detach self from the human world. The belief is that it is impossible to reach the spiritual state by employing realistic or direct methods. As a result, Chinese traditional music is characterized by thin texture, less musical activity, loose form, and ample silence in order to create a sense of vagueness and implication, or *Yun*. Again, silence in Chinese music does not necessarily mean emptiness or nothingness: like the principle of *Chán*, it is intentional and calls for the listener's imagination, ultimately resonating with the listener's inner world.

The Chinese plucked musical instrument family is a respectable addition to the musical world; the unavailability of long-held sustained notes on the plucked instruments has naturally caused the lack of continuity from note to note. Nevertheless, it is because of this discontinuity that Chinese music is unique. In a traditional guqin or guzheng piece, the discontinuity is not perceived as perceptual interruption. Instead, the musical energy is carried over and expanded into the silence between note events, allowing the listeners to absorb the sound and indeed feel the sound. Here, imaginative content embodied in the silence is considered as *Yun* in which the sounds resonate with the listener's perceptual experience. Thus, *Yun* is an expansion of the energy flow of the sound, as well as a state of the listener's perceptual transcendence from the physical world to the inner spiritual world. To a certain extent, it is a good application of the concept of "less is more."

In order to convey the sense of *Yun*, beyond the significant employment of silence, harmonics are widely applied in the Chinese plucked instrument family. From the perspective of physical acoustics, harmonics possess the purest timbre and, from the sonic result, the harmonics depict vagueness and emptiness, delivering a special reverberation effect. The reverberation, a sort of fluctuation between the actual sound and the implication beyond the sound, or between *have* and *have not* as explained in *Chán*, stimulates the listeners' spiritual perception and imagination, activates their emotions and enriches their aesthetic sensibility.

B. The Applications of Chinese Traditional Music in *Winter Landscape*

1. East-West Synthesis in *Winter Landscape*

a. Instrumentation: the combining of Western musical instruments with a Chinese traditional musical instrument

Winter Landscape is written for flute, erhu, piano, and computer. Erhu (Chinese two-stringed violin) as a traditional Chinese musical instrument was introduced to China from Central Asia around one thousand years ago. After a lengthy development, erhu gradually became a solo instrument at the beginning of the 20th century and is one of the most popular traditional musical instruments in China today.

In this version of *Winter Landscape*, a piano substitutes for Chinese zither (guzheng) due to the possible difficulty of finding a guzheng performer. Moreover, the composer intentionally borrowed numerous guzheng techniques and aesthetic practices, and integrated them into the piano writing in order to imbue the piano with a "plucked" character, such as exaggerated vibrato and glissandi, the various plucking techniques, and the idiomatic interpretations of grace notes. Specific examples include the wide application of staccatos, arpeggios, tremolo, and glissandi on the piano as well as playing inside the piano (mm. 47-52, movement I; m. 102, movement II; mm. 8-13, mm. 18-26, mm. 87-88, movement III), guzheng's stereotypical monophonic line (mm. 89-93, movement I), tapping on the wooden part, hitting inside the piano with the palm (mm. 66, 108-109, movement III), and other techniques.

Blending western musical instruments with a Chinese musical instrument and employing Chinese instrumental performing techniques on western instrument(s) reflects a recurring theme in my work which is the concept 'balance of dichotomy:' East vs. West, tradition vs. modernism, and acoustic vs. electronic. In this particular work the theme attempts to meld together three temporally and spatially distinct instrument groups – western instruments (flute and piano), a Chinese instrument (erhu), and computer – through utilization of the computer music language Max/MSP.

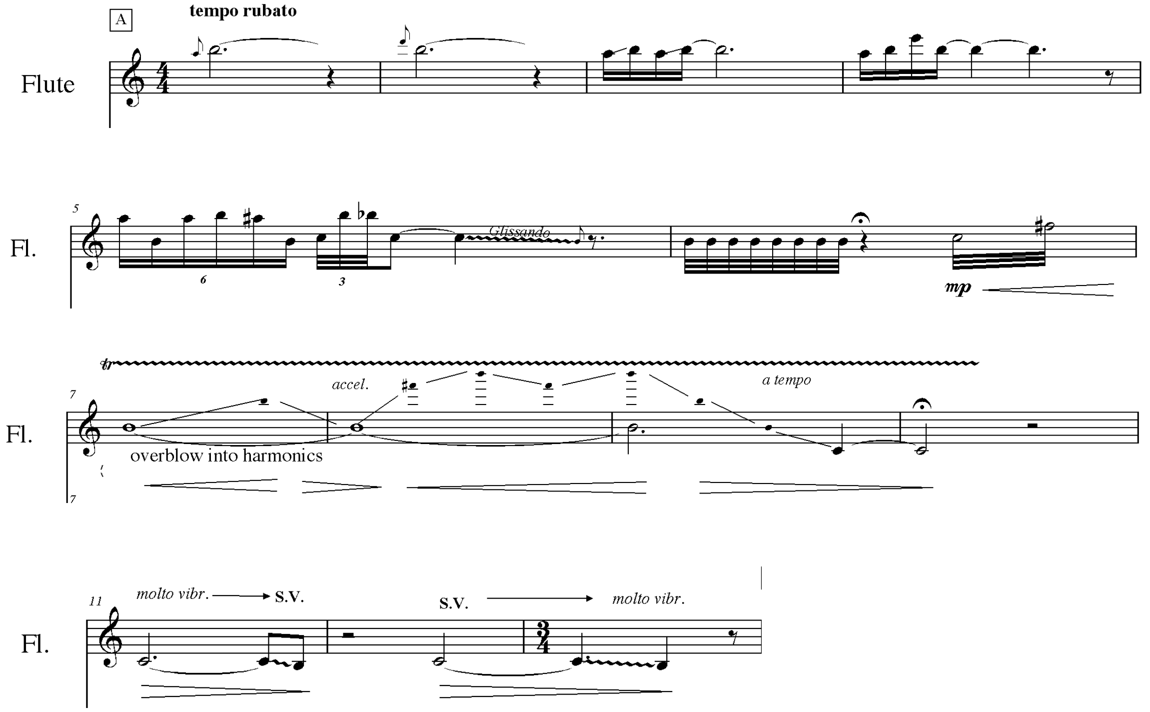
b. Pitch organization

Besides the mix of eastern and western musical instruments as well as the mix of ancient Chinese instruments and western modern technology, the pitch structure and the musical aesthetics in *Winter Landscape* also reveal the composer's east-west synthesis concept.

The idea of integrating Chinese and western musical elements is embodied in the design of the pitch organization in *Winter Landscape*. The modernized pentatonic scale (pentatonic fragments with added chromatic notes) makes a compromise for Chinese and western musical instruments to speak a contemporary and common language. The few examples listed below can further illustrate this concept.

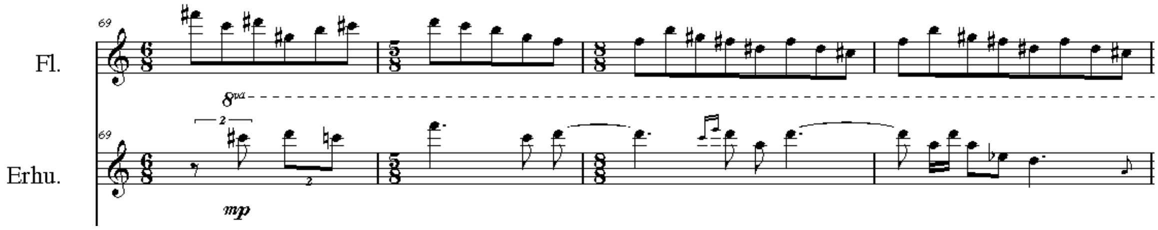
It is apparent that the music at rehearsal number A in the first movement is centered on the note B. (see Figure 3.1) In mm. 1-4 the notes construct the pentatonic fragment (A, B, D, E); mm. 5-6a are the ornamentation and elaboration of m. 4 with registral displacement and a chromatic interval—minor second (A#/Bb and C). Mm. 6b-13 are a further elaboration and colorization of the last note (C) of m. 5 and the first note (B) of m. 6 by applying tremolo, overblowing into harmonics, and subtly changing vibrato. The processes on the first page of this piece, integrating pentatonic fragments with chromatic intervals, later becomes the significant method governing the pitch structure of *Winter Landscape*.

Figure 3.1 mm. 1-13, Movement I.



Another example of blending pentatonic fragments with chromaticism can be found in mm. 69-72, movement II. (see Figure 3.2) In this case, the integration is realized in a linear fashion and presented in the melodic lines: a complete pentatonic scale (F#, G#, B, C#, D#, F#) would be constructed if all the flute notes except for B are sharpened. In order to chromatically color the melody, C, D, F, and G are altered occasionally and combined with the original pitches. The erhu part is applied with the same procedure: the pentatonic fragment C, D, F, (G), A is ornamented by C# (m. 69) and Eb (m. 72).

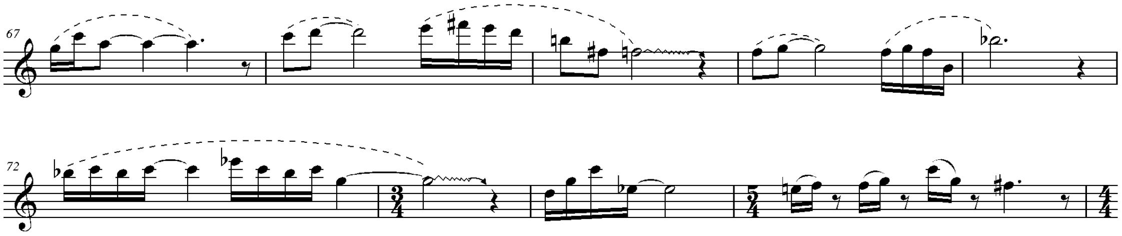
Figure 3.2 mm. 69-72, Movement II.



The intervals in the Chinese pentatonic scale consist of major seconds, major/minor thirds/sixths, and perfect fourths/fifths. The intervals absent in the scale include minor seconds, tritones, and major/minor sevenths. In *Winter Landscape*, the intervals presented in a pentatonic scale are considered as consonant intervals while the rest are considered as dissonant intervals. In other words, in this particular piece, the consonant intervals signify the pentatonic scale while the dissonant ones are associated with chromaticism. Thus, the definitions of "pentatonic scale" and "chromaticism" in this paper are slightly different than traditionally specified. The two score examples above, illustrated by the combination of pentatonic fragment and chromaticism, can also be explained as a blend of consonant and dissonant intervals in a contextual setting.

The following score excerpt can further illustrate the similar approach by the quick shift from pentatonic fragment 1 (G, A, C, D, E, G), fragment 2 (B, D, E, F#, (A), B), to fragment 3 (F, G, Bb, C, Eb, F). (see Figure 3.3) The notes F in m. 69, B in m. 70, D in m. 74, and E and F# in m. 75, interwoven with pentatonic fragments, serve as the dissonant components, enriching the skeletal melodic contour and thus endowing it with a "modern" flavor. The smooth transition and transformation among various pentatonic scales is achieved through the use of the pivot notes, resulting in the natural flow of the melody.

Figure 3.3 mm. 67-75. Movement III.



2. Formal Structure—*Circular Form*

The typical formal design of Chinese traditional music reveals a structure of a large suite: free—slow—medium—fast—free, showing a strong emphasis on the *tempo rubato* section (Wang, 23). The principle of this formal design reflects the notion of integration and naturalness. As mentioned previously, the process of this form, illustrating a complete set of gradually- and naturally-developed emotional stages, is the product of Chinese philosophy. The "naturalness" of this form corresponds to the law of nature: the circular and repetitive pattern of natural existence while the "integration" echoes a logical and complete process of beginning, development, variety, and ending, which are intact and inseparable.

This particular type of formal structure that combines integration and naturalness, which is widely applied in Chinese traditional opera, ballad, singing and dancing, and instrumental music, is considered as the most representative form. For example, the formal design of *san qi—ru dao—ru man—(fu qi)—ru san* in Chinese guqin music, as well as the *tempo rubato—largo—andante—allegro—tempo rubato* are structural designs in Chinese ancient *TangSong Da Qu* (唐宋大曲), *qu pai* (曲牌), and *ban qiang* (板腔).

As mentioned in the first Chapter, *Winter Landscape* comprises three movements: I) *A sprinkle begins to fall…*; II) *Little dance of snowflakes*; III) *Snow spell*. The tempi applied in the main bodies of the three movements displays a gradual temporal acceleration. Combined with *tempo rubato* in Introduction and Coda, the formal structure of *Winter Landscape* outlines a large suite design: free—slow—medium—fast—free.

From a microscopic level, the circular form is applied in the second movement and written in a rondo form: as the title suggests, the movement is intended to depict the dancing posture of the snowflakes. The recurring theme appearing in the rondo form implies the circularity of the falling snow. In addition, from a macroscopic level the Recapitulation (Section C) of movement III also serves as the recapitulation of the entire piece by utilizing the common notes—pitch cell [0, 2, 5]—as the primary generative device. In this manner, the formal structure of the piece reveals a large form of A-B-A^1, transmitting a sense of circularity from a larger scale and evoking the principles of integration, circularity, and naturalness, as exemplified in the formal design of Chinese traditional music.

3. The Quotation of the Chinese Guqin Tune *White Snow*

Guqin, an ancient stringed instrument, is considered one of the oldest and most representative musical instruments in Chinese culture. Since it has traditionally been played by scholars and intellectuals and associated with Confucianism and *Chán* as an instrument of great elegance, guqin serves as an ideal carrier for the application of Chinese musical elements, such as structure and form, and becomes a symbolic representation of Chinese culture. It is often referred as "the father of Chinese music" or "the music of the sages." (http://en.wikipedia.org/wiki/Guqin) The old saying in ancient China that "a gentleman does not part with his (gu)*qin* or *se* without good reason" (Li Ji: Quli, second half 礼记·曲礼 下) illustrates the social importance of the guqin.

The Guqin tune *White Snow* was supposedly composed by *Shi Kuang*, a musician in the Spring and Autumn Period (770-476 B.C.). Combined with another guqin tune *Springtime*, *White Snow* has become the most representative work of Chinese classical music.

White Snow was initially included in "Mysterious Scores" which was found during the Ming dynasty (1368-1644). On the score it indicates that *White Snow* is intended to depict the stern and clean nature that the snow possesses (《白雪》取凛然清洁，雪竹琳琅之音), as well as the tranquil and peaceful artistic conception the snow conveys. The beautiful snowflakes fall silently to the earth—a seemingly unpopulated (empty) world; then the boisterous world, because of the snow's covering, is turned into a pure and simple land and is shrouded in peace.

The guqin's cultural and social associations and the artistic conception that *White Snow* conveys, prompted the careful selection of the guqin tune *White Snow* to enhance and highlight the influences of Chinese philosophy and Chinese music in this particular setting. This ancient Chinese tune, lingering faintly among the other musical instruments in *Winter Landscape*, communicates a sense of temporality and spaciousness and a desire of acquiring a spotless mind and ultimately, a peaceful world.

4. The Application of *Yun*

Although the natural landscape has been a popular and an attractive subject in many Chinese music compositions, the direct depiction and reproduction of nature are carefully avoided. In other words, the natural landscape itself carries little weight. Rather, implication and *Yun* is emphasized and conveyed through the sounds, generating a sound world that is reminiscent of *Aftertone of Infinity* (Joseph Schwantner) and instigating the positive resonance on the spiritual level. For instance, *Fisherman's Song* for guqin is not intended to depict the river or the rhythmic motion of the boat; rather, it conveys the fisherman's joy of being detached from the human world and his temporarily pure freedom. Accordingly, it strives to depict a higher level of spiritual life. The implication beyond the sound reveals the aesthetic conception of the unity of "world" and "self", or a blend of "object" and "subject".

To attain *Yun*, one of the practices is to strive to endow each musical note with life, vitality, and personality, hence making every note delectable and meaningful. In *Winter Landscape*, the silence and the single musical event are animated, personalized and exaggerated as the devices to transmit *Yun*. For example, the silence and the discontinuity between note events are not intended to simply create the sense of emptiness; rather, they carry over the energy from the preceding note to the next one, inspiring a perceptual transformation from the physical level (the sound) to the spiritual level (the *Yun*).

In regard to the concept of a single musical event that is different from its function in western music, in which each event is the smallest unit subject to a larger musical gesture, the individuality and separateness of each note is stressed and exaggerated in *Winter Landscape*: the "head", "body", and "tail" of a note are endowed with great significance. For instance, the gradual shift from *molto vibrato* to *senza vibrato* (or vice versa) on the flute and the subtle change of vibrato speeds on the erhu are carefully designed, carrying the life and personality of each note.

The subtle alterations between continuity and discontinuity in sounds resemble the cursive writing style of Chinese calligraphy: separated but still together in spirit. Musically, while the sound ceases the aftertaste still lingers. As a conclusion, *Yun* is a concept of “spirit-resonance, life-movement” in which the sound produced by musical instruments vibrates with the listener’s spirit, enabling the transcendence from the sound to the spirit.

Interactivity Between Performers and Computer

As described in Chapter 1, interactive music is real-time two-way dialogue that takes place between live performer(s) and a computer. In a real-time interactive music performance system, the performer plays a traditionally notated score and/or improvises on his instrument along with a pre-programmed computer. The computer, acting as a "virtual" performer, *listens* to its counterpart's performance, *analyzes* the parameters of the audio signal, *locates* the position in the score, and *responds* to the live performer. Through this role-playing, interactivity between the performer and the computer is accomplished by their respective abilities of listening (to each other), analyzing (performance events/parameters), allocating (their scores), and responding/playing.

A. Stages of Interactivity

1. Listening Stage

In a real-time interactive environment, the computer's algorithmically generated artificial musical expressions cannot match the innate musical expression a live performer delivers. Fortunately, fast CPU technology enables a computer to "listen" with the use of microphones that transduce atmospheric energy or the sound pressure of an original sound into an electromagnetic signal that can be transduced into digits in the computer. The sampling and quantizing process that takes place enables the original sound to be captured, converted, stored, and used as computer data. As an analogy, the digitizing process makes the sound listenable to the computer's virtual ears. The subsequent functions of analyzing, allocating, and responding on the computer, originating from the listening stage, are the vital parts for interactivity.

2. Analysis and Allocating Stage

During the analysis process, the computer evaluates the incoming audio signal so that the individual parameters, such as frequency, amplitude, envelope, overtone components, and even pitch/rhythmic patterns can be detected and stored. The devices utilized to track various musical events are event detectors. According to the particular musical characteristics of the piece, detectors for pitch, attack/amplitude, phrase, note/rhythm prevalence, and other musical attributes are purposely designed in order to accurately capture specific musical information.

Due to the performer's humanistic interpretation of rhythmic patterns and tempi, artificial intelligence is often needed for the computer to follow the live musician's performance. The ears of the computer must function as do those of a human being. Therefore, the parameters acquired from the analysis process enable the computer to follow and allocate the current position of the live performance, which provides a prerequisite for the synchronization of the computer score with the performer's score in real-time. The attained performance parameter data can also be used for triggering a series of musical events programmed in the computer, converting/mapping the data to control the various aspects of the computer-generated score, modifying signals (i.e. creating digital sound effects or imposing the time-varying envelope on another sound by means of modulation), and so on. Though the analysis stage is a critical element of an interactive paradigm, it cannot by itself be considered as a real interactive performance since it only provides a premise for the subsequent interactivity occurring between the live performer and the computer.

3. Responding/Playing Stage

A computer's artificial intelligence in interactive music is especially demonstrated in the responding/playing stage. During this stage, the computer functions as an effect module, an artificial instrument (a synthetic instrument constructed electronically and algorithmically in the computer through programming), and/or an improviser.

a. Computer as an Effect Module

An effect module built by the programmer modifies the live sound with special effects. In interactive music, most of the effect modules are delay-based, denoting that the computer makes multiple copies of the incoming signals in a specified time period and then modifies these delayed signals by means of various signal-processing algorithms (note: even in the realm of sound synthesis, the parameters in the control structure are largely derived from the live performer, introducing another kind of delay). All of the delay-based processes shadow and color the live acoustic instrument because of the time delay between the original signal and its transformations. Since most effect modules are based on the modification of the delayed signals, they are inevitably predictable to a certain degree. Thus, excessive use of effect modules might easily cause listening fatigue. Effect modules built into the genre of pieces for interactive music performance fit into the concept of interactivity. However, from the resulting sound, the levels of responsiveness/autonomy and the functionality of the computer, they belong to a relatively lower category of interactivity. Barry Moon's concept of "computer as bagpipes"[2] humorously and truthfully reveals the functionality of effect modules as an instrumental extension.

b. Computer as an Artificial Musical Instrument and/or a Live Improviser

A more sophisticated type of interactivity is to build a timbrally similar or contrasting synthetic instrument that plays back a pre-programmed score or improvises based upon the expressive characteristics derived from live performer. Theoretically, the computer can generate any kind of sound—either emulating an acoustic sound or producing a complex or unusual tone. However, the mathematical and sonic complexity generated by the computer, in most cases, is unequal to the inherent complexity of an acoustic sound produced by a human performer. The disparity in sound quality and musical expressions subsequently becomes a main issue for the programmer/composer to struggle with and control. The use of effect modules mentioned previously provides one application of using the timbral disparity between the human performer and computer to enhance contrast. A more intricate approach of stimulating interactivity between these two "performers" is to humanize the computer so that human performer and computer can express musical ideas on a relatively equivalent level, thus diminishing disparity. Utilizing the complex musical characteristics created by the live performer to shape the computer's data structure and musical expressivity is a widespread attempt to facilitate interactivity between the real and the artificial performers on a balanced level.

The three increasingly complex levels of interactivity and responsiveness are: 1) triggering sound

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[2] Cort Lippe, *A Look at Performer/Machine Interaction Using Real-Time Systems* (Proceedings of the International Computer Music Conference 1996, 1996) 117.

files in direct response to performer input; 2) triggering effect-modules; and 3) using artificial intelligence to generate musical materials. Simple triggering is the most direct task for the computer since the assignment largely lays on the accuracy of the design of event detectors, thus requiring less interactivity. Since effect module triggering manipulates live audio input, it can be considered to be a higher level of interactivity that utilizes both event detectors and algorithmically generated effects. Finally, the roles of an artificial instrument and improviser involve much more intensive designs and calculations, thus the highest level of interactivity.

The construction of an artificial musical instrument either implies a matched realism or modifies an acoustic timbre through both the analysis of the original sound and the synthesis of the attained parameters. Since Frequency Modulation is one of the most versatile and computationally efficient synthesis techniques to generate a sound with rich harmonic components, it is often extensively used for constructing new sounds. In terms of the computer's role as an improviser, this is often accomplished by "stealing" the human performer's musical expressivity/characteristics, analyzing and modifying the obtained performance data accordingly, juxtaposing the modifications to several voices, applying various sound-processing algorithms to each voice, and responding to the human performer with contrapuntal texture. By these means, human-computer interaction becomes a more intelligent modality of construction that can create an engaging real-time interactive music-performing environment.

B. Analysis Stage: Event Detectors in *Winter Landscape*

In *Winter Landscape*, various event detectors, served as the artificial cognitive system of the computer program, are applied to the recognition of pitch, amplitude, phrase, and rhythm. Since the accuracy of the detectors provides a premise for subsequently successful triggering, strategies are developed to ensure the reliability of the captured information in this given piece.

1. Simple Amplitude- and Pitch-Based Track Engine

a. Amplitude Detector: to trigger various musical events or control other DSP parameters

Amplitude tracking in an interactive music system is a relatively simple task for the computer. As its name implies, an amplitude detector tracks the amplitude component of an audio signal. The structure of an amplitude-detector, despite a variety of approaches in terms of structural design, normally consists of four essential parts: the placement of a low-pass filter (Figure 4.1) prior to the signal-detecting process; the snapshots of the audio signal in a periodic interval; a threshold value set according to the physical nature of the acoustic instrument; and a comparison of the amplitude value of the incoming signal with the threshold in order to output an amplitude parameter or an attack report. Additional adjustment is usually required for reliable detection depending on the nature of the acoustic instrument and particular performance issues.

Figures 4.2 and 4.3 illustrate two different designs of an amplitude detector. The former is a prototype of an amplitude detector, including all four essential parts mentioned above, while the latter, applied in *Winter Landscape*, originates from the prototype with modifications specifically designed for the instrumentation. Since the signal flow of the amplitude detector demonstrated in Figure 4.2 is self-explanatory, the amplitude detector as seen in Figure 4.3 will be elaborated upon.

Figure 4.1 Low-pass filter

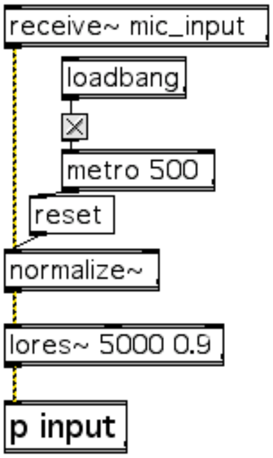


Figure 4.2 Amplitude detector prototype (*Z. Settel*, 2)

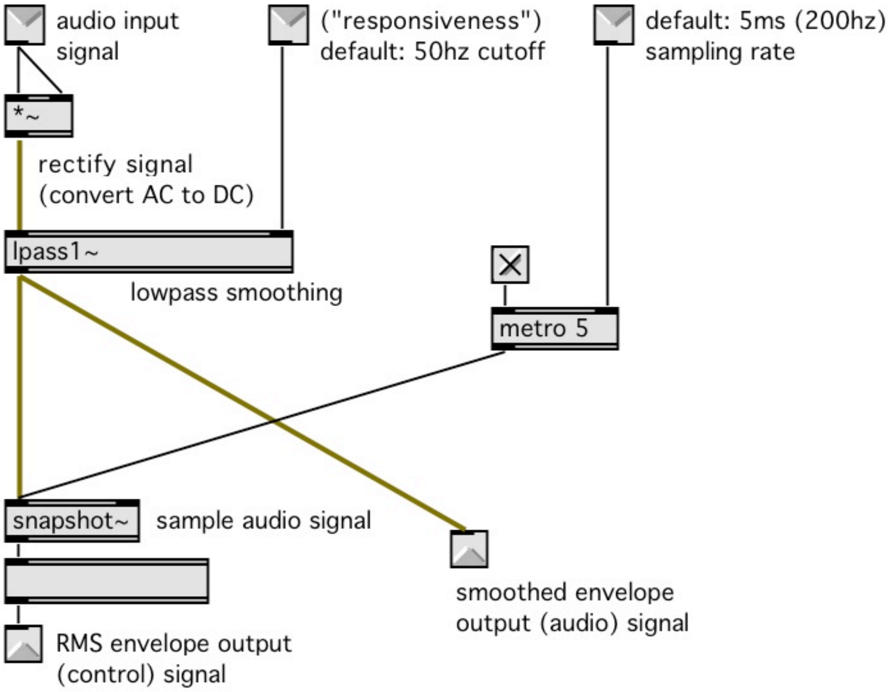
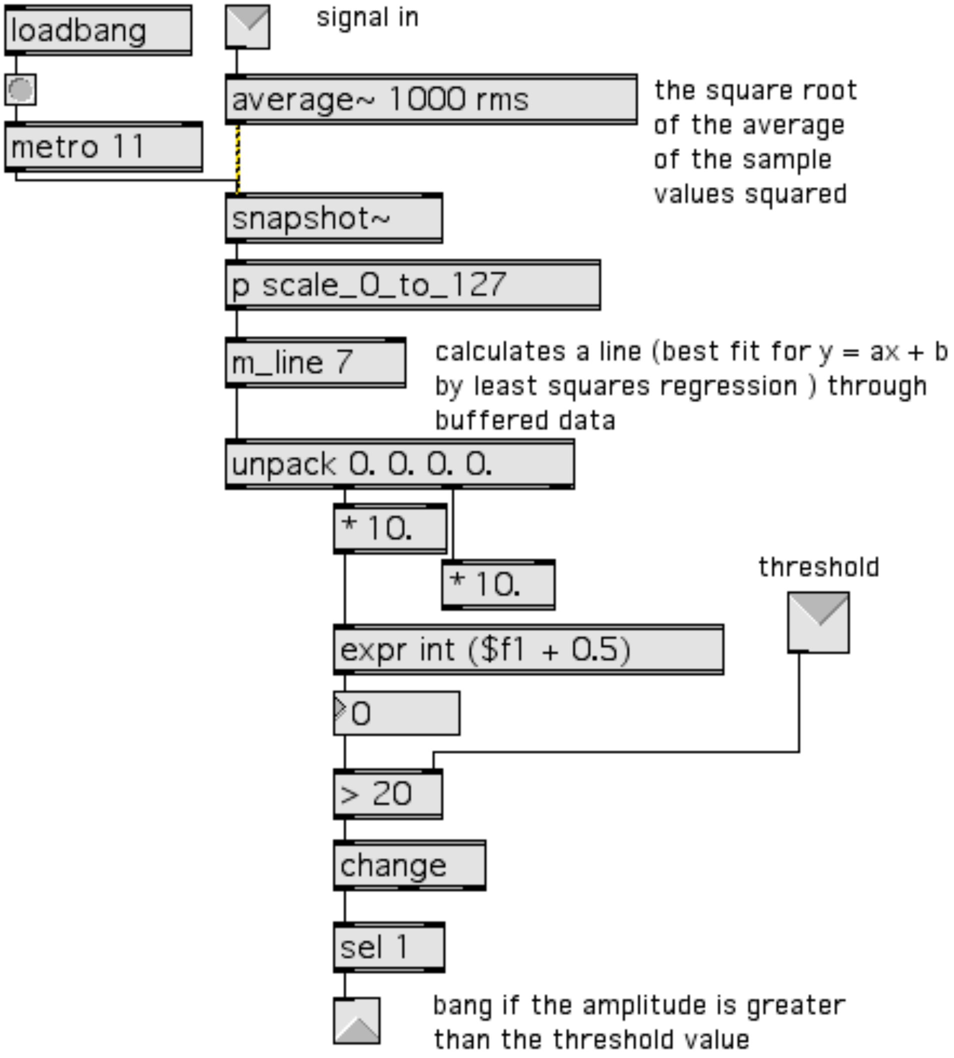


Figure 4.3 Amplitude detector used in *Winter Landscape* (May, 2005)



In the tracking model illustrated in Figure 4.3, several adjustments are made to ensure more stable detection: for example, the running mean amplitude of a signal is averaged over a specified number of samples through the RMS (root mean squared) mode by employing the object *average~ 1000 rms*. The object *m_line 7* is programmed to calculate a line of buffered data (best fit for y = ax + b by least squares regression), which ensures the capturing of accurate and meaningful amplitude data. The four output values, from left to right, are point value (b in y = ax + b), slope value (a in ax + b), standard deviation (rms error between line and actual data), and range of x values (+/- r). In this particular illustration, only the slope value is used and scaled as the amplitude value. Lastly, the setting of the threshold is crucial to the accuracy of the amplitude detection. Different instruments, or even the same instrument performed in a different acoustic space, are likely to require slight adjustments of the threshold value.

The process of sound analysis and synthesis to a certain extent is analogous to uncovering the DNA of a living organism, and then inventing new gene sequences and new forms of life. The procedure and purpose of various event detectors is to de-compose the sound and sort out the individual parameters from an interwoven structure. The resultant data from the analysis process can be interpolated and mapped to any other parameters in order to highlight connections between different musical events, which in turn stimulate musical expressivity and interactivity.

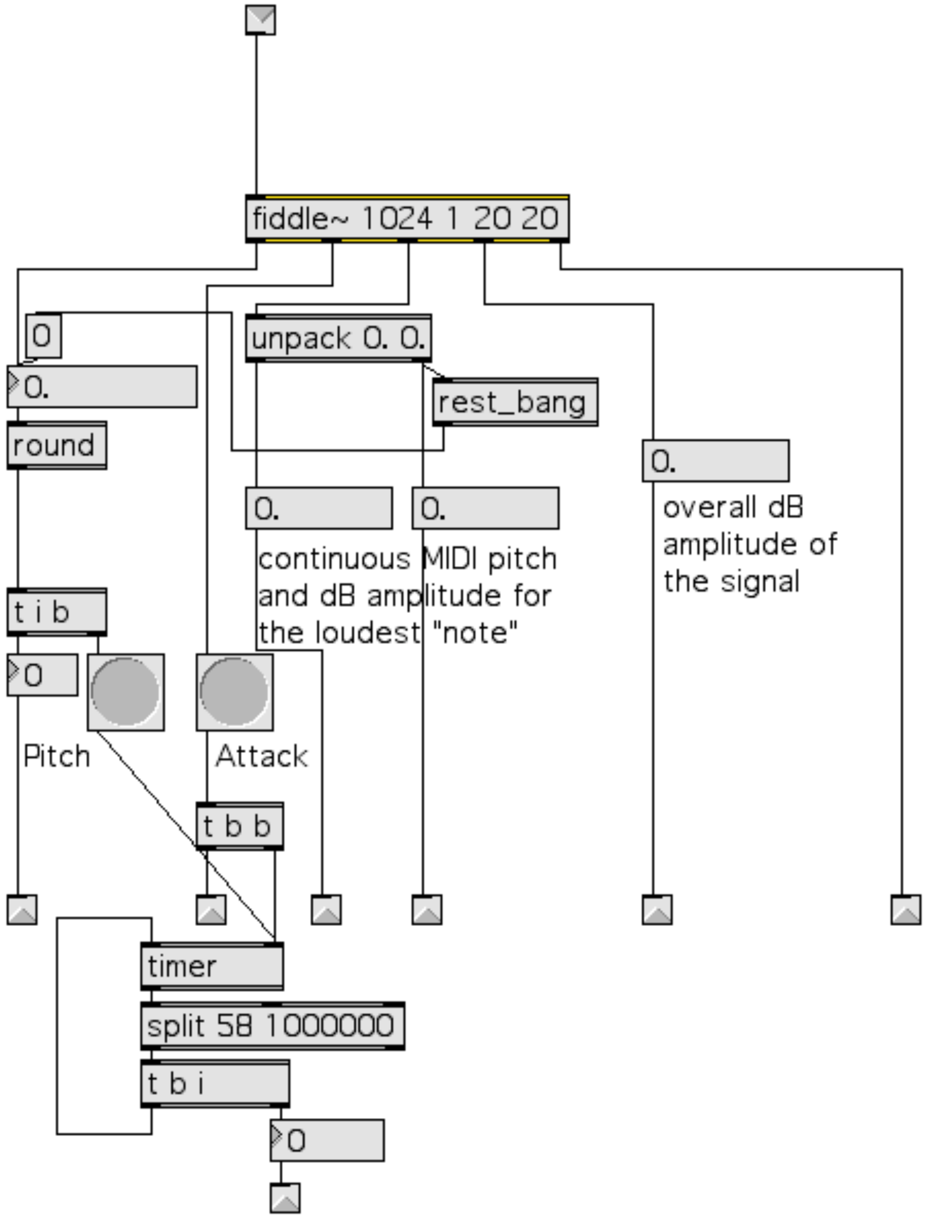
As a result, the output of an amplitude tracking could be applied to make musical decisions in a variety of ways. For instance, the result of the final comparison (between the amplitude of the incoming signal and the specified threshold) can be employed to trigger various musical events (e.g. activating effect modules or playing back a specified sound file). In a more advanced way, the amplitude value can be modified and interpolated to control other signal parameters (as frequently applied in *Winter Landscape*), such as the size of delay buffer of the granular effect, the transposition intervals of the harmonizer, or the voice number of the poly-time-stretch module. The amplitude values captured from the live instrument can even be stored into a *buffer~* object, connected and converted as a pitch or rhythmic pattern for the creation of a corresponding motif. Certainly, the goal of all these decisions is to create musically interesting computer-generated materials.

b. Pitch Detector: to switch on-off DSP processing, trigger harmonizers, and change the parameters of FM synthesis

Since pitch is one of the most characteristic elements in all pitched acoustic instruments, pitch tracking is extensively used for the purpose of triggering musical events, allocating music score, and providing a means of data-mapping and transformation.

The *fiddle~* object is used extensively by programmers and composers, as are several other pitch-detecting objects such as pitch~ and yin~. *Fiddle~* has proven to be one of the most stable pitch-detecting tools for most Western classical musical instruments in which the individual stable fundamental frequency can be easily captured and analyzed. Figure 4.4 provides an example of the use of *fiddle~*. In this example, an incoming signal is fed into *fiddle~* while the output is parsed into several data streams. The *fiddle~* object performs a FFT analysis of the incoming audio data stream. The information coming out from different outlets includes the raw pitch, continuous MIDI pitch and dB amplitude for the loudest “note,” overall amplitude of the signal, and absolute duration of each “note.” In most cases, the detected raw pitch parameter could directly be used in a number of ways with satisfying stability and reliability.

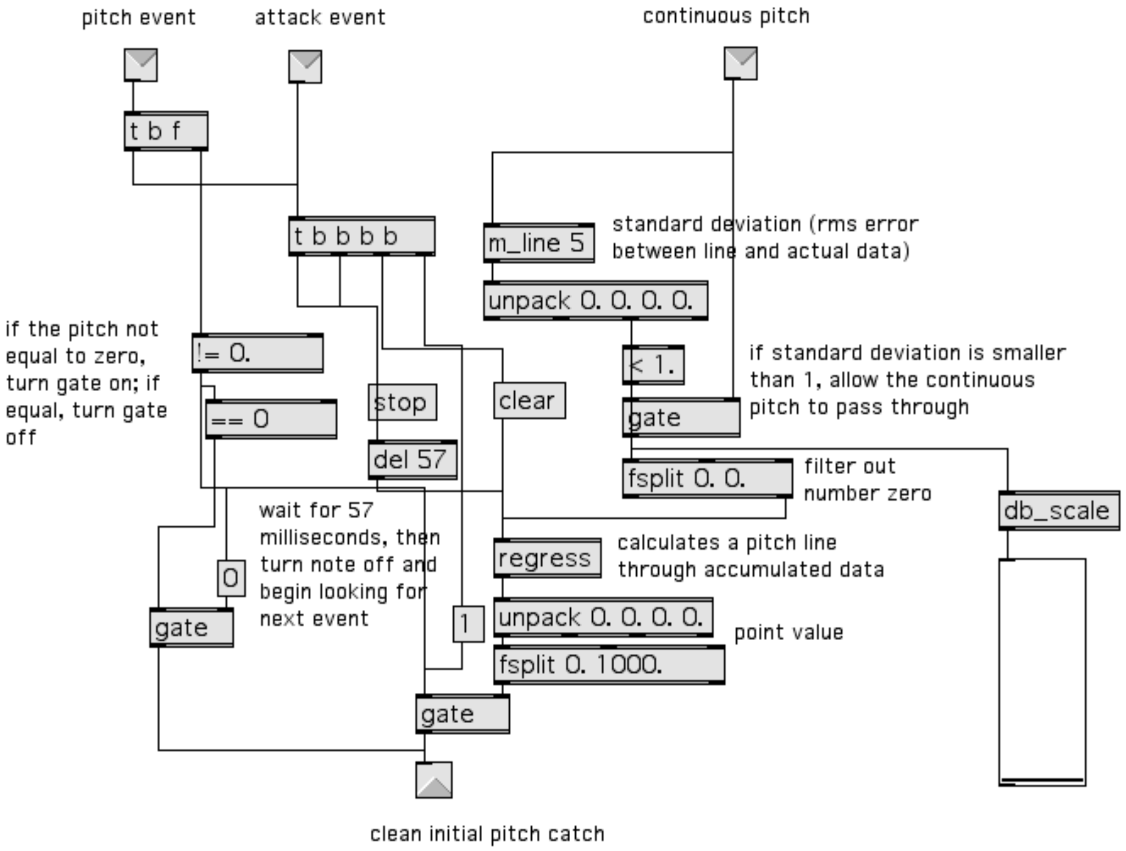
Figure 4.4 Fiddle parse



In particular situations, a refinement may be necessary to guarantee a more accurate and efficient performance. For instance, in a fast musical passage a series of notes are played with very short durations. To execute efficient pitch detection in this scenario, one might choose to filter out the “insignificant” notes (e.g. the passing tones) and concentrate on the skeletal tones that have relatively longer durations. As it is natural for human performers to play the significant notes with more physical strength while playing the “insignificant” notes with less strength, it follows that a good method of filtering out the fast passing tones is to combine a pitch detector with an amplitude detector: thus, only those notes having sufficient amplitude will be captured for pitch detection. In short, the general goal of the refinement of a pitch detector is to eliminate the unwanted signal and filter out the spurious data. A refined version of a pitch detector is demonstrated in Figure 4.5.

As to the application of the pitch (frequency) parameters received in the outlets of a pitch detector, the data can be used in numerous ways to control other musical parameters, such as the frequency of a synthetic instrument, the delay time of a flanger, and/or the cutoff frequency or the Q factor of a filter in real-time. As with amplitude data, the individual pitches can be stored in a buffer~ object in a specified order, applied with a rhythmic pattern (which might be derived from the amplitude detection), and/or played back as a variation of the original motif.

Figure 4.5 Refinement of pitch detector (May, 2005)



2. Extension of Amplitude and Pitch Detector

a. Phrase Detector: to control DSP parameter changes

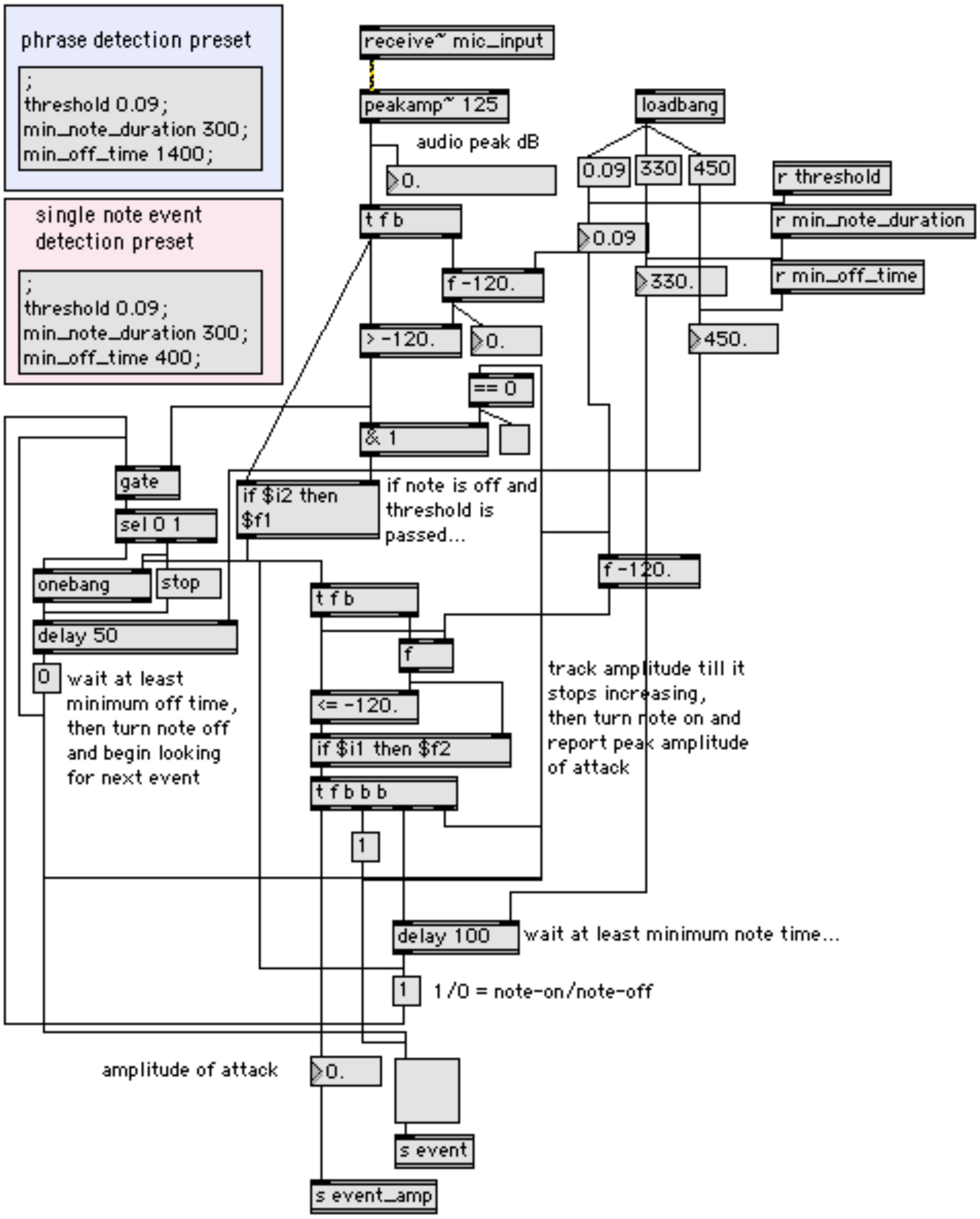
A phrase detector is to track and allocate phrase information. In Western classical music, a phrase is usually indicated by its harmonic progression, and/or a complete statement of a melodic or rhythmic idea. Moreover, the ending of a phrase is typically characterized by silence or repose. For this reason, it is feasible to expand the idea of amplitude tracking one step further to construct a phrase detector. Since an amplitude detector identifies the amplitude of a note, the note-on (attack point) and note-off (ending point) events can be easily tracked through an analysis-based technique. Specifically speaking, a note-on message is sent out if the note goes above an amplitude threshold specified by the programmer and a note-off message is sent if the note goes below a release threshold. Applied to phrase tracking, and based upon the fact that the presence of some silence often indicates the end of a phrase, the conceptualization of a phrase detector includes a setting of the following parameters: 1) overall phrase duration (15000 ms for example); 2) the phrase attack point threshold (note-on information for the first note of the phrase); 3) the phrase release point threshold (duration of silence), announcing the closing of the phrase. Only when all these conditions are met is a phrase detected.

The presumption described above for phrase tracking is a theoretical and ideal hypothesis. In an actual performance and programming situation, false triggering usually occurs due to the acoustic complexity of an instrument, as well as a variety of performance issues. For example, the wide vibrato ranges on the woodwind and string (especially the low string) instruments can cause the amplitudes to fluctuate above and below the threshold very quickly, even within a single note event. As a result, simply applying the prototype of the aforementioned phrase detector would cause the computer to identify the up-and-down amplitude of the vibratos as several repetitive notes, thus causing inaccurate assessment. One solution for such a misdetection is to set up a “wait time” for a note event: if the amplitude fluctuation of the vibratos takes place within the *wait time*, the computer ignores the subtle information between and considers it as a part of the single note event. In other words, a minimum note duration can be specified, less than which a note event continues. As illustrated in Figure 4.6, the phrase detector applied in *Winter landscape* comprises the amplitude of the incoming signal, amplitude threshold, minimum note duration, and minimum wait time.

An additional factor for many woodwind and string instruments is their gradual attack and release amplitude, which means that even though the signal might pass the detecting threshold at the very beginning, the actual attack peak might take place several milliseconds later. As a result, a solution needs to be devised for such a particularity for the sake of an accurate detection. To solve this problem the computer can “look” for the tendency of the amplitude after the audio signal passes the attack threshold. If the tendency remains stable or increases, the computer understands it is still approaching its peak amplitude and ignores it, while if the amplitude diminishes, it immediately sends out a peak attack value. In this manner false evaluation is avoided. The middle part of Figure 4.6 illustrates this solution by postponing reporting the peak value until the amplitude stops increasing.

In terms of the musical application of the phrase information captured by a phrase detector in *Winter Landscape*, the phrase length function is utilized to govern the starting and ending points of a pre-processed sound file that is triggered by an amplitude detector. The peak amplitude is modified to regulate the loudness and/or tempo of this sound file. Furthermore, the durations of each note in a phrase are calculated and stored for the creation of a new rhythmic motif.

Figure 4.6 Phrase detector (adapted from Dobrian's *sound event detector*)



b. Note Prevalence Detector: to trigger delay-based looping device

In a traditional musical composition a motif constructed on a characteristic melodic or rhythmic cell is often the fundamental idea exploited to govern and regulate the development of a composition, as well as to provide the formal structure of the same. The motif sometimes appears as the unmodified melodic statement and sometimes with variations, governing the musical unity and variety, and thus, the coherence of the piece. Applying the same idea to real-time interactive music, it would be valuable if the primary pitch cell (or pitch class set) could be detected and analyzed for the triggering of a musical event or allocating the music score. Analytically, if the most-frequently-played pc set concealed in a musical phrase is successfully recognized, it can be used as the motivic cell for a synthetic instrument to play back or improvise upon. A note prevalence detector can accomplish this task.

To design a note prevalence detector, a logical flow should be structured as follows: specify a given number of note groups for analysis→find the *normal order* and then *prime form* of the note group→compare the pc set of this note group with pre-stored pc set numbers→if matches are detected send out a confirmation and store that information→count and compare the matched pc sets and then find the pc set with the highest prevalence. Figure 4.7 illustrates the procedures of finding the set class of a note group. There are procedures embedded within each subpatch that perform the following tasks:

i) remove_duplicate_classes listens to incoming pitch data and removes duplicate pitch classes.

ii) four_note_lists assembles a list containing four pitches, reduces them to one octave (%12) to determine pitch classes, and finds the normal order.

iii) gimme_four sorts the notes in ascending order and reduces the transposition to level zero. It also finds other set forms including its inversion (subtract from 12 to avoid negatives), the four rotations for prime form and four rotations for the inversion and inverse forms, with all transposed to level zero.

iv) normal_order_of_four assigns a score to each set form, hierarchically valuing a) the bounding interval; b) first interval; c) and second interval.

v) compare_lists chooses the set form with the lowest penalty score to actually determine the best normal order by first resetting, then iteratively testing penalty scores.

vi) the left outlet of the object “t l l” sends out the best solution (*best normal order*) of the note group, in this case, a four-note group.

Figure 4.7 Best Normal Order Finder (May, 2005)

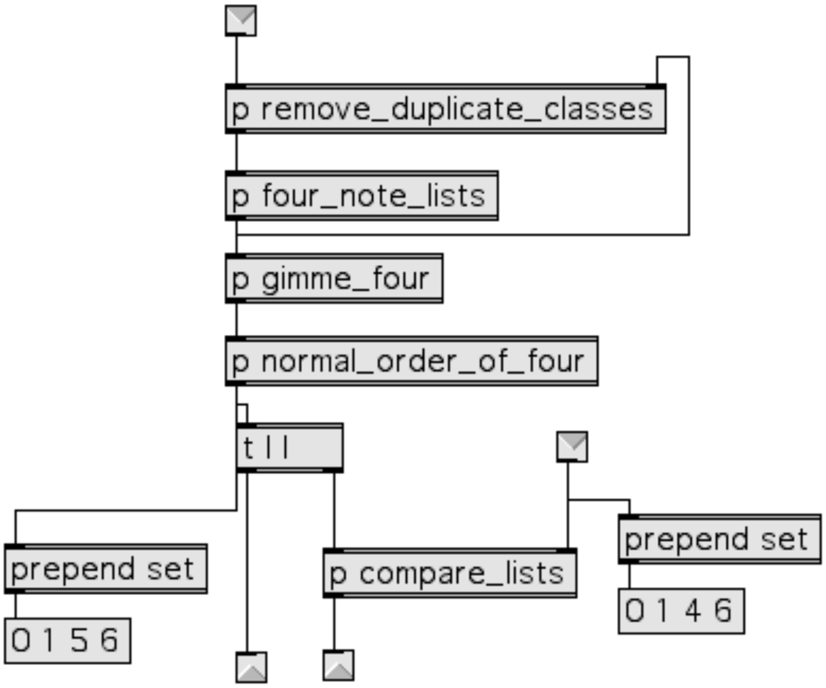
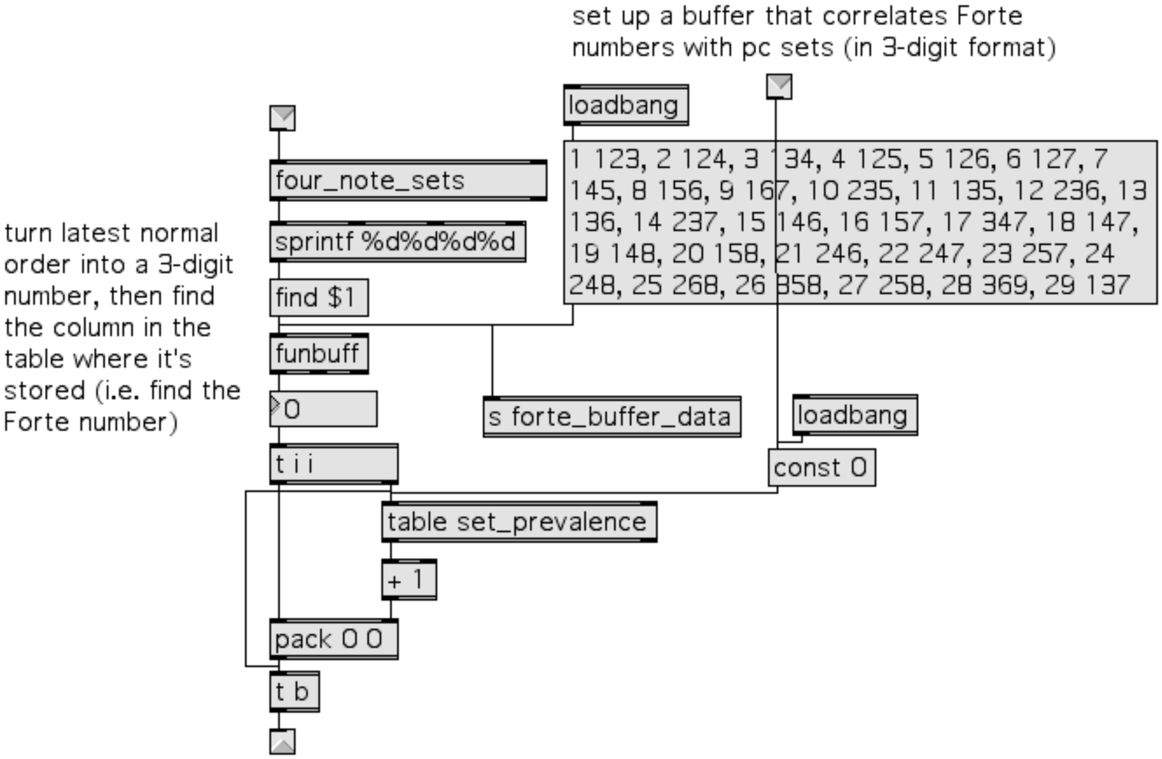


Figure 4.8 exhibits the process of comparing the *best normal order* of the four-note groups with pc set numbers that are pre-stored in the buffer. On the right side, the list stored in the message box correlates with Forte numbers in a 3-digit format (123 represents [0123] since all the sets start with 0) and the first number in each pair of numbers represents the ordinal number (1, 2, 3…). On the left side, the *normal order* of the four notes is converted to 3-digit in order to match the format of the pc sets stored in the buffer. The left outlet of the *funbuff* object sends out the column number that corresponds to the ordinal number in the list (i.e., the number "3" corresponds to the third number group in the list, which is 3 1 3 4). The object *table set_prevalence* embodies a graphical display of the calculation of each pc set: the ones most commonly used are presented with greater magnitude.

Figure 4.8 Comparison of the Best Normal Order with pc set (May, 2005)



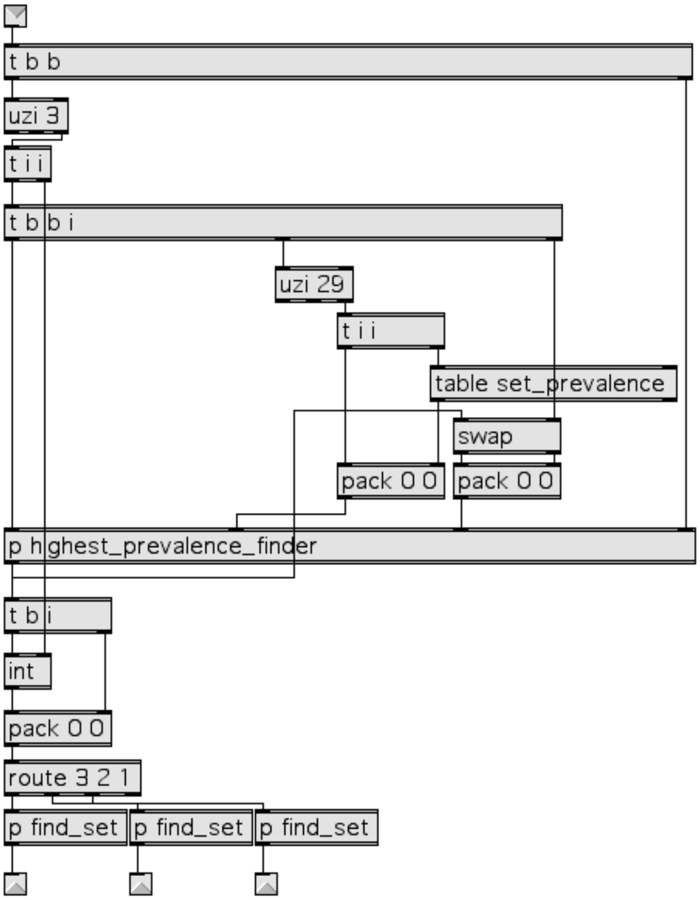
set up a buffer that correlates Forte numbers with pc sets (in 3-digit format)

1 123, 2 124, 3 134, 4 125, 5 126, 6 127, 7 145, 8 156, 9 167, 10 235, 11 135, 12 236, 13 136, 14 237, 15 146, 16 157, 17 347, 18 147, 19 148, 20 158, 21 246, 22 247, 23 257, 24 248, 25 268, 26 358, 27 258, 28 369, 29 137

turn latest normal order into a 3-digit number, then find the column in the table where it's stored (i.e. find the Forte number)

The most-commonly-played pc sets are selected and arranged in ascending order according to their magnitudes, as seen in Figure 4.9. In this particular example, the three most-commonly-played pc sets are reported as the result. As aforementioned, the three pc sets could be combined to generate pitch content for the computer's derivative improvisation, providing another demonstration of an effective approach of integrating unity (a shared motivic idea) with variety (modifications/variations on the pitch content for playing back on a synthetic instrument). This data could similarly be used to trigger a delay-based looping device (e.g. the occurrence of the same pc set activates a specified looping process).

Figure 4.9 Highest prevalence finder (May, 2005)



The note prevalence detector tracks and identifies the pitch class set of a note group and finds the most-commonly-played one through the subpatch *highest_prevalence_finder*. As a corollary, a rhythm prevalence detector can easily be adapted based upon a very similar algorithm with minor adjustments. In this application, instead of finding a four-note set form, the goal is changed to find the most-commonly-played four-note rhythmic pattern. Accordingly, the object *timer* is called for to find the duration between note events, a process accomplished by an amplitude detector. For instance, the programmer can use one duration (e.g., a quarter note) as the point of reference and represent rhythm as integers, resulting in

reference duration (a quarter note) = 0

then eighth note = -1, sixteenth = -2, thirty-second = -3, etc.

and half note = 1, whole note = 2, breve = 3…

Since a pattern played at different speeds should be recognized as the same pattern given that all the notes share the same proportional ratio in terms of duration, this is analogous to the concept of transpositional equivalence and registral displacement presented in pitch class set theory. Since the essential structure of building a rhythm prevalence detector is equivalent to that of the note prevalence detector, there is no need to go into further detail in this paper.

C. Computer As an Artificial Musical Instrument and a Responsive Improviser

1. Virtual Instrument: FM synthesis to create ever-changing timbre

As previously mentioned, higher level interactivity endows the computer with the roles of both a sophisticated musical instrument and an experienced improviser. In order to match the charisma of a real performer, the design of the instrument and the corresponding improvisation should be based upon expressivity “borrowed” from the live performer by analyzing and synthesizing the expressive sound and gestures derived from the human performer. The computer can emulate the sound and gestures with or without modifications depending on the desired musical context. Only in this way is interactivity generated on an equal footing.

As a development of the note prevalence detecting model described above, an artificial musical instrument could either directly play back the most-commonly-played pitch class sets or make an elaborate improvisation based upon the sets. During its improvisation process, a computer could react to its input in a pre-determined way, whereas unpredictability could be accomplished by the application of algorithmic randomness at some structural level.

The first task in designing an artificial instrument is to determine its timbre. As applied in the second movement of *Winter Landscape*, the percussive sonic character found in the acoustic score coupled with the sporadic nature of the sound makes percussive sound an ideal timbral companion to colorize the piano and the granular effect. Among synthesis techniques, Frequency Modulation (FM) is considered as one of the most computationally efficient techniques since the rich complex sounds generated with FM contain many harmonic components, even though only two oscillators are required to produce the sound. Simply speaking, FM is achieved by adding a time-varying signal (Modulator Frequency) to the constant frequency (Carrier Frequency) of an oscillator. (MSP Tutorial, 112) The modulator is added to the constant base frequency of the carrier. Due to its computational efficiency and its ability to produce a wide variety of timbres, FM is chosen for musical instrument construction in *Winter Landscape*.

Figure 4.10 shows a modification of a standard FM synthesis. In this implementation the pitch parameter that is derived from the live performer is used as the carrier frequency, as well as the source for the modulator frequency's algorithm (*expr $f1 / 200. + 3.*). A noise resource, commonly used for the emulation of a percussion instrument in sound synthesis, is also applied. The FM synthesis model illustrated in Figure 4.10 serves as a sonic prototype that is similar to the concept of "motif" in the process of musical composition for the creation of a complex tone in *Winter Landscape*.

The sonic motif resulting from the FM sound is then embedded inside *perc_synth*. As exemplified in Figure 4.11, six percussion synthesizers are combined and respectively assigned with different pitch and amplitude parameters derived from the live performance in a given order specified by *index*. In this manner, a synthetic percussion instrument is assembled.

Figure 4.10 FM synthesis subpatch

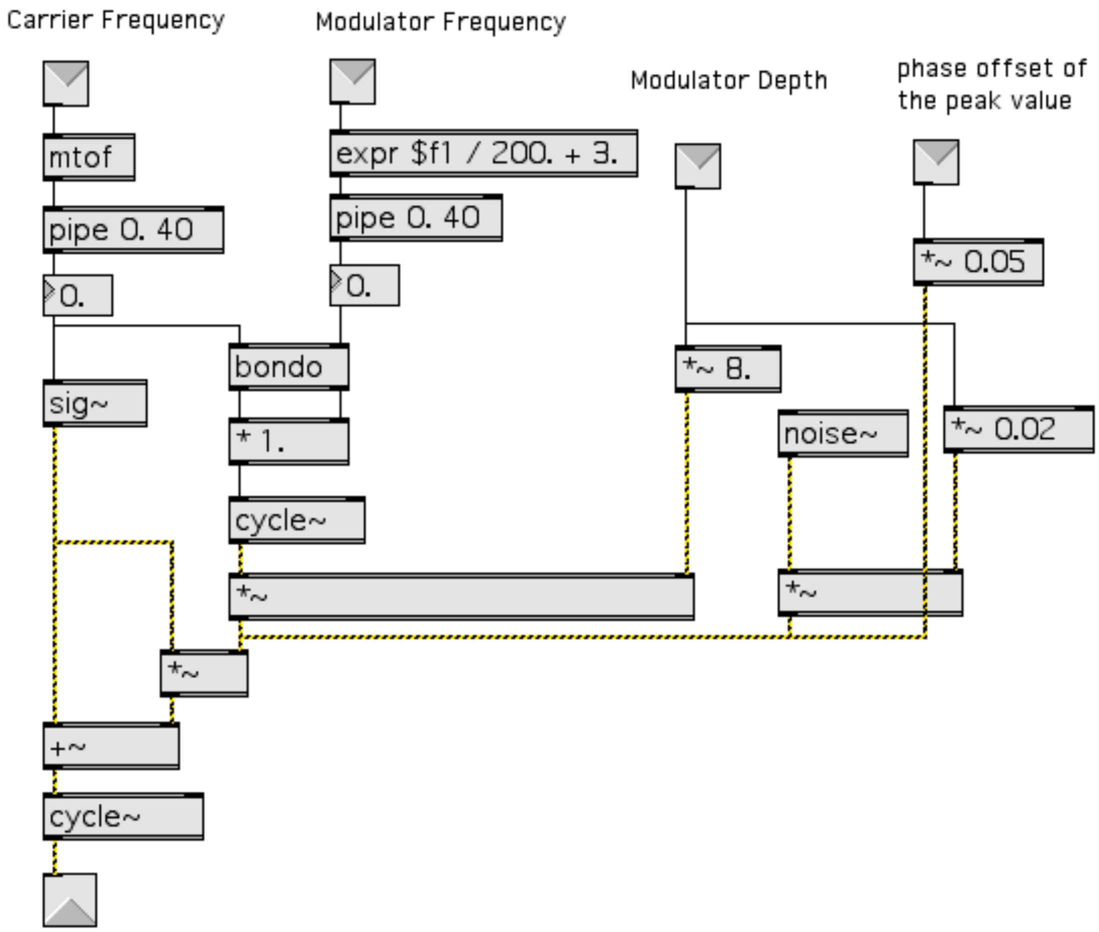
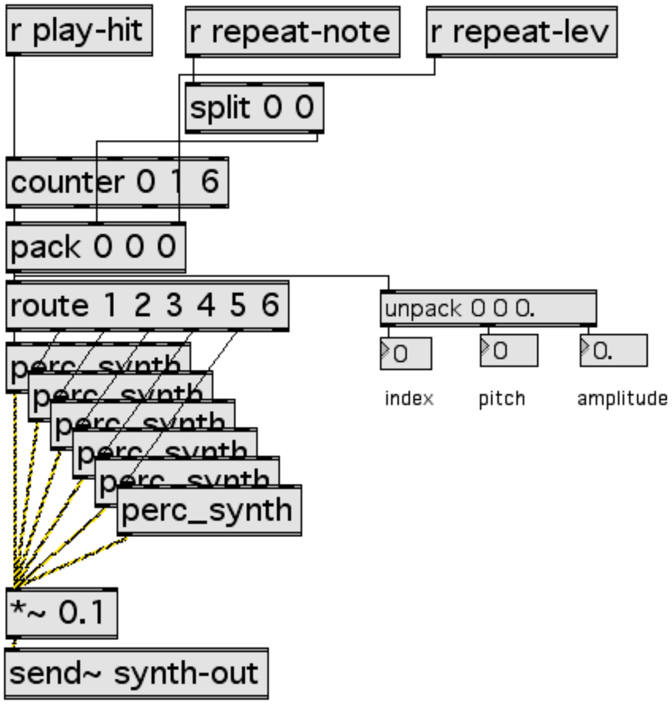


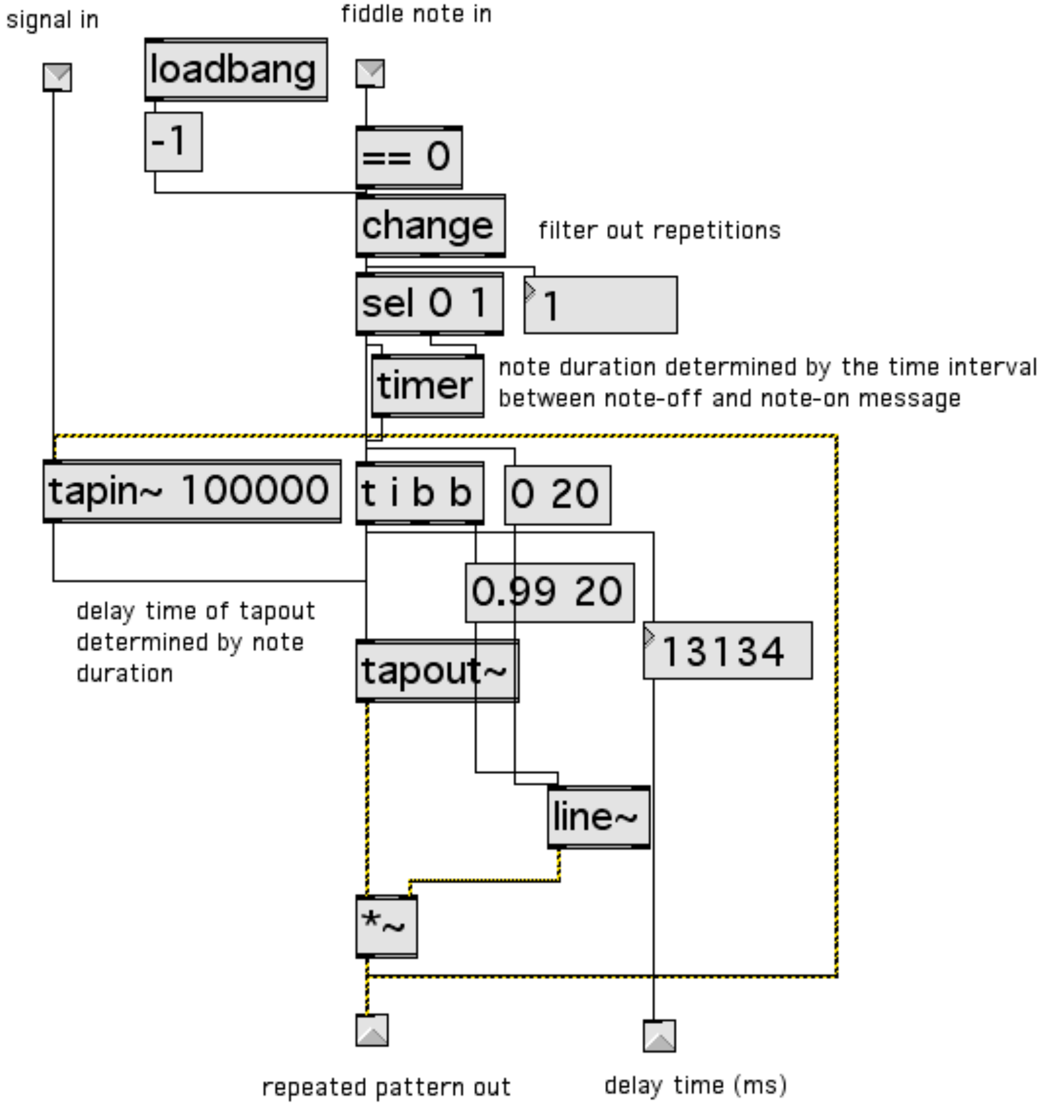
Figure 4.11 Percussion instrument synthesis



2. Contrapuntal Texture Generator

After building the percussive instrument one must specify how this instrument should be played; in other words, how this instrument should interact with the human performer. As discussed previously, a responsive and sensitive performance of the computer should reduce the disparity between the artificial and real performers. As a result, *Winter Landscape* strives to capture the characteristic and expressive sound gestures created by the acoustic instruments and then assign the computer to either replicate the gestures or make variations played on the synthetic instrument made from FM. Figure 4.12 illustrates a simple emulation of the rhythmic pattern played by the acoustic instrument with slight modifications. Since the synthetic instrument produces a muffled marimba timbre in this example, it imposes another layer/texture on top of the original sound, functioning as a rhythmic emulator to the acoustic instruments. Instead of incorporating strict imitation, the FM instrument is assigned with a certain degree of structural freedom and randomness to generate a polyphonic texture.

Figure 4.12 Rhythmic emulator of live instrument (May, 2005)



Another example is in the second movement of *Winter Landscape*. Since the most-commonly-played pitch class sets are captured and analyzed through the note prevalence detector and since the design of the synthetic instrument is accomplished, it is effortless for computer to play back the pc sets as linear melodic lines or polyphonic textures or as vertical harmonies. Despite the inherent logic in this sort of approach, the sonic result may not always be interesting. Therefore a little modification is useful. Just like the variation techniques applied in acoustic music composition, the modification of the pc sets can be laid on various levels, such as pitch transposition, rhythmic compression or expansion, inversion or retrograde of the original order, adding of ornamentation pitches, or any combination of the techniques mentioned above. For the computer, all the modifications are uncomplicated since all the parameters, no matter which domain they belong to, are in the format of digits and can be easily converted and transformed.

The subpatches shown in Figures 4.13 and 4.14 are part of a patch demonstrating a combined application of the computer’s role as an artificial musical instrument as well as an improviser who responds to the gestures produced by the human performer. The signal processing is divided into three sections: the synthetic instrument as the original signal, the processed synthetic instrument, and the control of the level of the bell effect imposed on the processed synthetic instrument. In terms of the resulting sounds generated by the three layers, the original synthetic sound outputs audio that shadows the rhythmic pattern of the original sound source with a muffled marimba-like timbre. The processed synthesizer not only borrows the rhythmic pattern of the synthetic sound but also employs a chime-like timbre with a similar melodic contour to the live acoustic instrument albeit with variable pitch content. The third layer “bell factor” colorizes the processed synthetic sound with an adjustable degree of bell effect that obscures the sense of pitch clarity created by the second layer, enhancing the sense of a non-pitched bell-like instrument.

Figure 4.13 below illustrates the process of the synthetic instrument and indicates how this responds to the parameters derived from the live acoustic instrument, while Figure 4.14 exhibits the overall control of the mixing level of the three different layers: the original sound, the processed sound, and the bell factor.

Figure 4.13 Synthetic instrument processing (May, 2005)

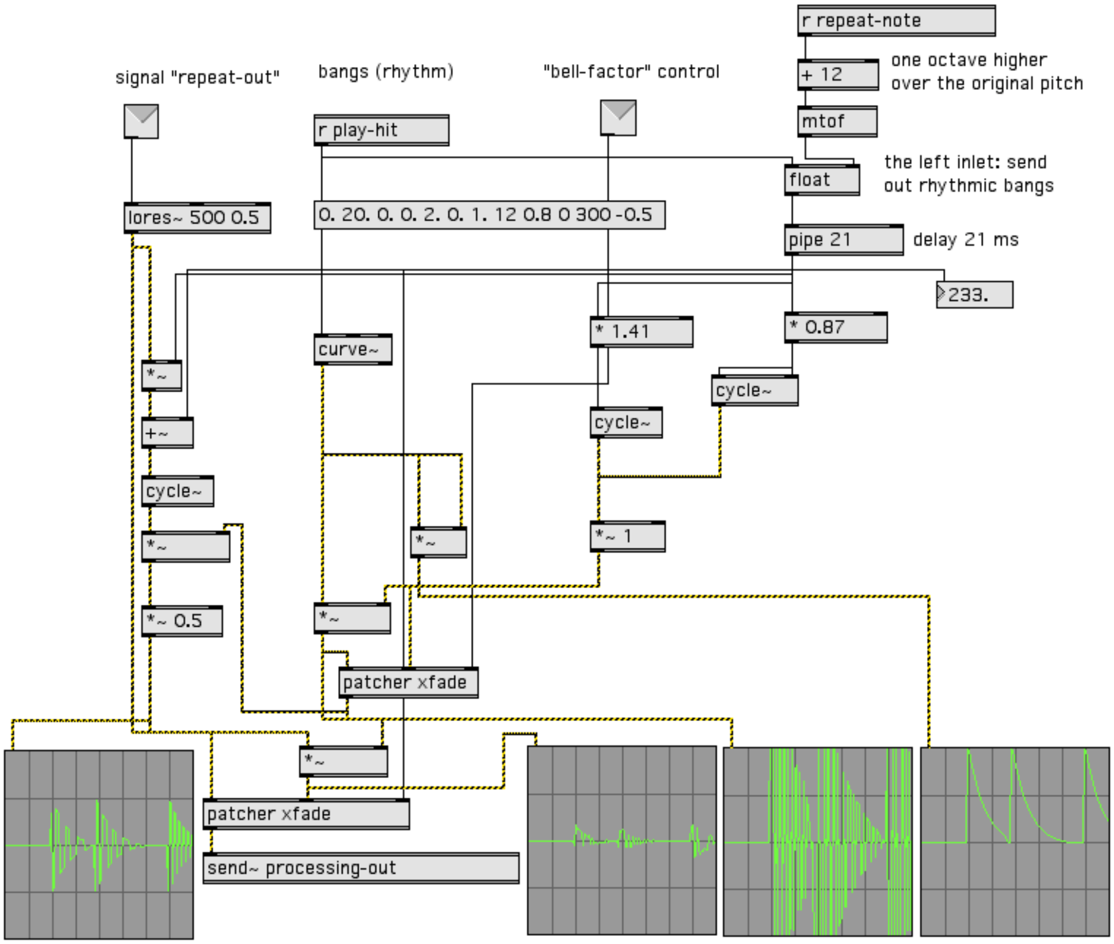
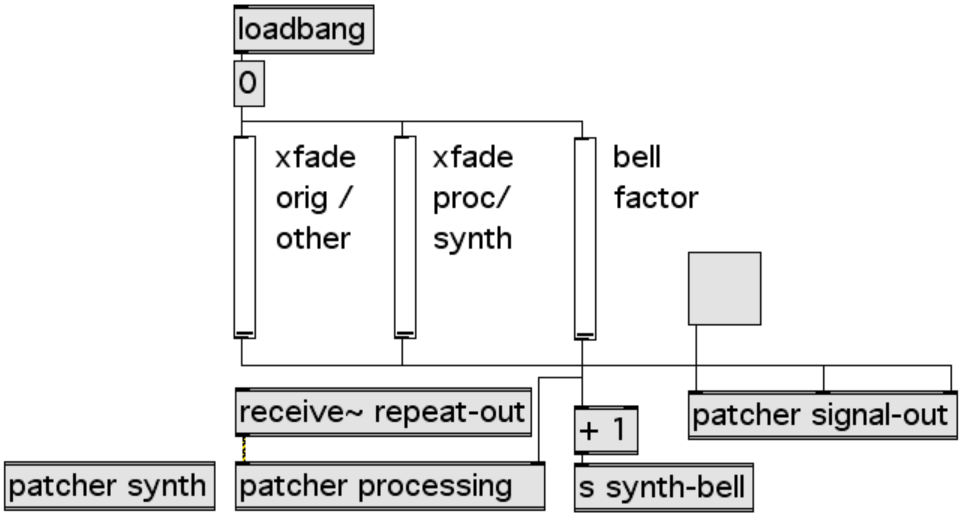


Figure 4.14 Control of three layers: the original signal, processed sound, and bell factor



The three layers, sharing certain pitch and/or rhythmic parameters but with respective modifications and randomness of various degrees, are juxtaposed simultaneously, creating a complex contrapuntal texture. The consequential sound reflects a close relationship with the sound produced by the original acoustic instrument and also demonstrates a relatively independent decision-making ability, revealing a skillful interactivity and expressivity as a contrapuntal texture generator. In addition, the three layers are applied with cross-fade control so that the mixing level of all the sounds can be adjusted.

Other Technical Considerations

A. Audio Signal Routing and Mixing in Max/MSP

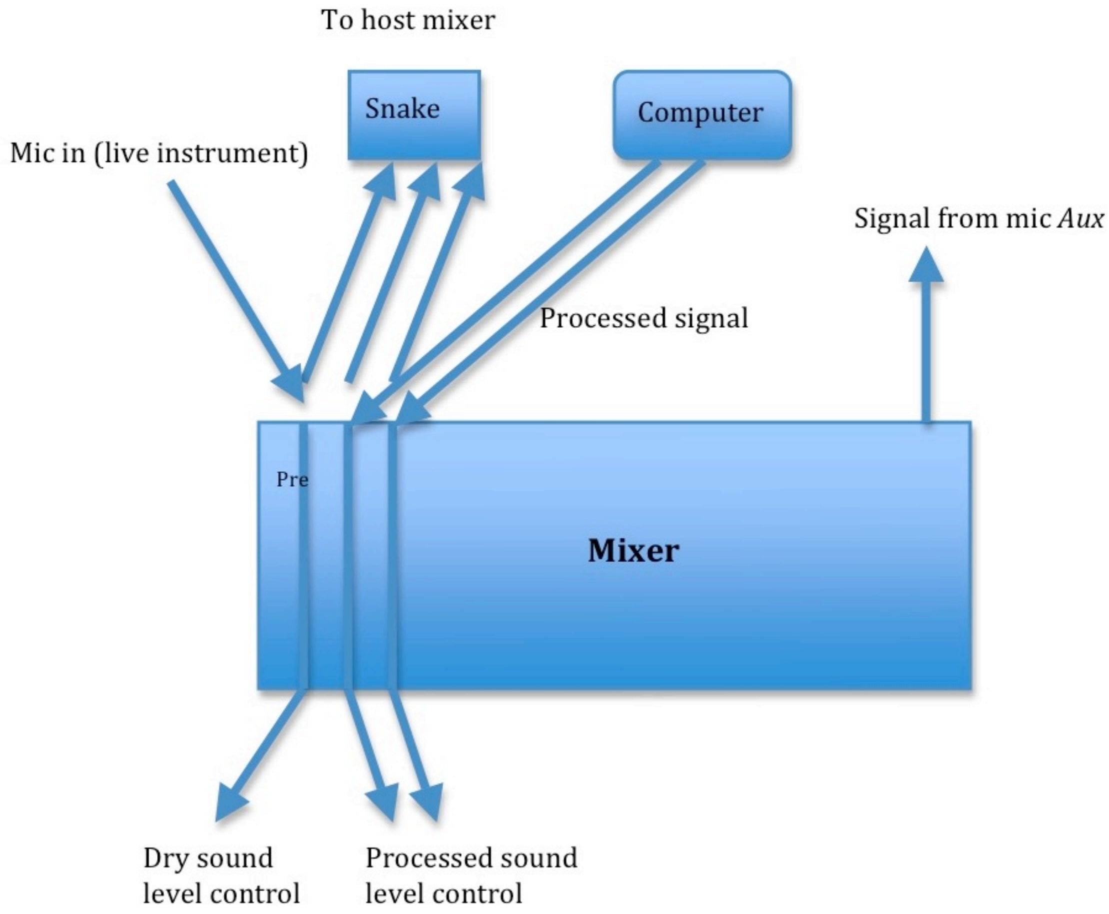
Due to the limited rehearsal time at a conference or festival, an interactive music performer should prepare all the essential equipment and setup configurations prior to rehearsal in a timely manner. Normally, for a real-time interactive performance, three cables are routed for carrying the output of the performer's equipment to the main mixer provided by the conference host. The following diagram (Figure 5.1) illustrates one of the most standard configurations used in many interactive music performance venues (note: Snake is provided by the conference host and connected to the main mixer).

In this particular configuration, in order to attain individual control over the levels of both the dry signal and the wet signal, the following setups are called for to ensure a manageable performance:

i) When the microphone is connected to the performer's own mixer (guest mixer), use the *pre-fader* mode to enable the fader of the corresponding channel to control just the dry signal of the live instrument through the *direct out*, without disturbing the volume being sent to the computer via *aux*.

ii) The processed sound in the computer is sent to the guest mixer through the *post-fader* so that the volume of the processed signal can be individually adjusted before sending it out to the host mixer.

Figure 5.1 Configuration of an interactive performance system



This configuration provides the great advantage of isolating the volume of the dry signal received from the live instrument and the wet signal derived from the processed sound so they can be controlled individually before signals diffuse to the host mixer. A controllable volume balance is thus obtained.

B. CPU Efficiency (matrix~, mute~, etc.) Considerations

1. A Brief Explanation of DSP Status Window in Max/MSP: I/O Vector Size vs. Signal Vector Size

The I/O vector size refers to the number of samples that are transferred to and from the audio interface at one time. In order words, the I/O vector size specifies the magnitude of a package of samples for digital processing.

The signal vector size determines the number of samples MSP objects process at one time; that is to say, the number of audio samples MSP calculates at a time. For example, if the I/O vector size is 256 and the sampling rate is 44.1 KHz, the audio length that MSP can manage at a time is approximately 5.8 ms (256/44.1).

Therefore, the smaller the I/O vector size, the greater the resultant CPU workload (intensity). One of the shortcomings of assigning a small I/O vector size is that DAC (digital audio converter) slip or click is easily caused by any processing interruption that results from the lack of sufficient time for MSP to process imperative information. However, if the I/O vector size is increased, noticeable delays become inevitable.

The change of signal vector size will not influence the latency of audio signal, except for the impact on the overall performance of the computer. Generally speaking, the larger the signal vector size the better the computer's performance. Nevertheless, some MSP objects, such as *tapin~*, *tapout~*, prefer a smaller signal vector size since the smallest delay time generated in these objects equals the number of samples contained in the signal vector in a specified sampling rate. For instance, if the signal vector size is 64 and the sampling rate is 44.1KHz, the smallest delay produced in *tapin~* and *tapout~* is 1.45 ms (64/44.1). As a general rule, the signal vector size must be smaller than or equal to I/O vector size.

2. MSP Objects Economizing CPU Consumption

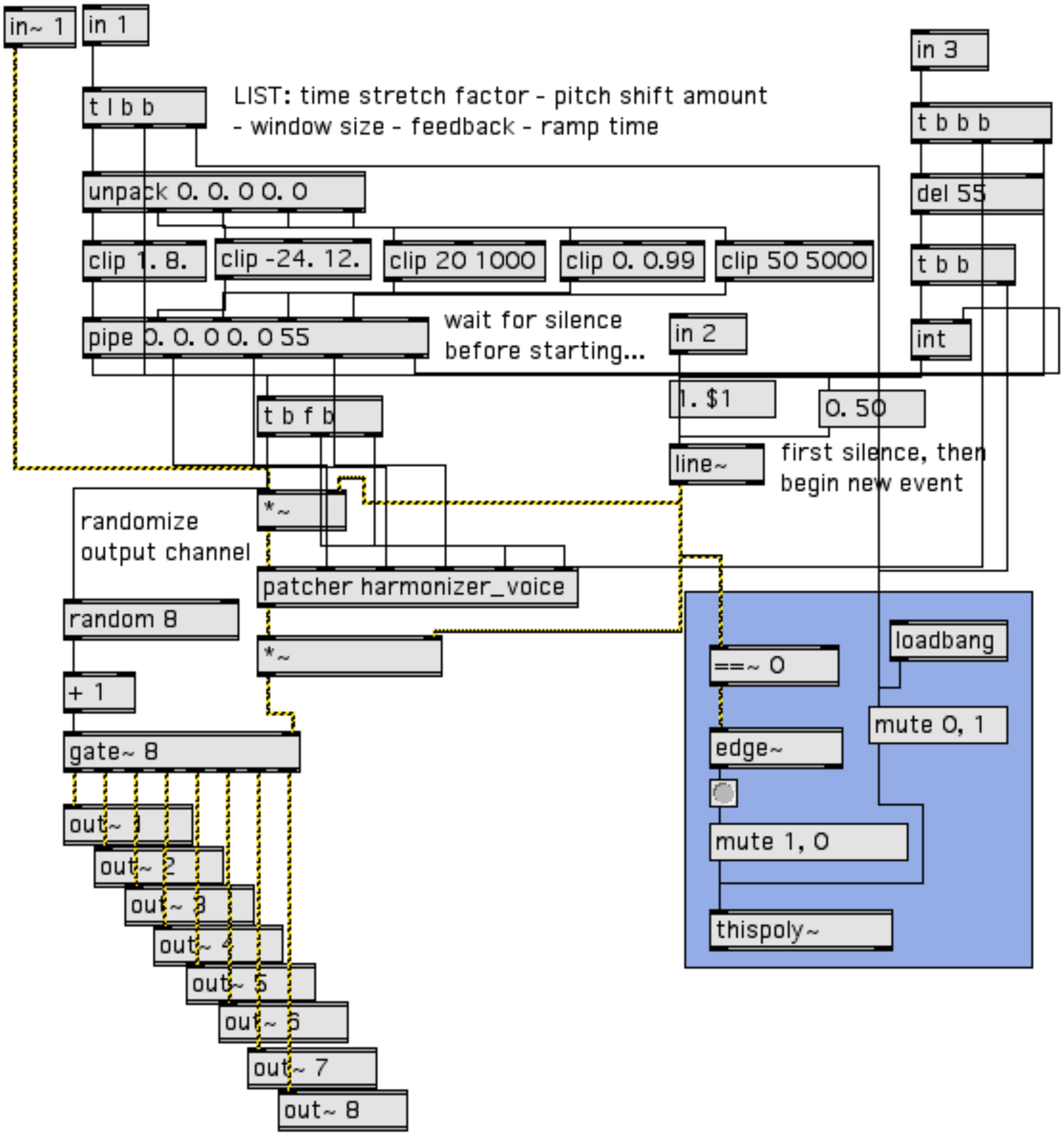
CPU load is directly correlated to the processing intensity, such as the number of simultaneous modules used and the I/O vector size. The efficiency of CPU consumption is one of the most important factors that a programmer needs to consider, since it requires that one balances the desire to avoid audio clicks from DAC slip while avoiding noticeable delays. These factors can determine the success of an interactive performance: an efficient use of CPU can maximize the computer's computational ability while minimizing (optimizing) the digital resources. Within Max/MSP there are numerous strategies to economize CPU consumption, including avoiding the overuse of graphical objects such as signal level fader, signal scope, and waveform display, simplifying the user interface, and optimizing signal flow. Due to the significance of CPU consumption management, a few MSP objects are designed and utilized specifically for this purpose.

The Max/MSP object *mute~*, paired with *pass~*, is broadly used in *Winter Landscape* to optimize CPU consumption by individually turning on/off audio processing within each signal module. The *mute~* and *pass~* pairs turn on/off the audio signal flow of subpatches without interrupting that of the main patch, saving CPU cycles while guaranteeing that one doesn't create additional unwanted audio.

Another use of the *mute* function can be found inside the subpatch *poly~ harm_tstretch_poly 8*. This is a multi-delay processor in which the incoming signal is fed into 8 channels with different delay times, producing diverse pitch transposition as well as varied time delays. Since the 8 channels respond to the input signal in a somewhat random way, each channel has various lengths of silences. Running several simultaneous DSP modules (8 in this case) is CPU-intensive. Consequently, it is most efficient to enable each channel to automatically turn on/off its signal chain based upon the detected amplitude values: i.e., turn it off when the volume goes below a specified release threshold and turn it back on when it goes above an attack threshold, using an amplitude detector. The following diagram (the portion highlighted in blue in Figure 5.2) illustrates such an application. Here, *thispoly~* reports *poly~* instance numbers and controls voice allocation and muting. A value of 0 or 1 turns off/on the "busy" state of the object. While an object is “busy,” the object will stop receiving messages via the *poly~* object's note or midinote messages. This sort of extensive use of the *mute~* object in *Winter Landscape* enables and disables each individual DSP processor (especially in multi-channel processing), providing an efficient control of the collections of processor-intensive modules.

The *matrix~* object has also been used broadly by programmers for the purpose of optimizing CPU consumption. *Matrix~* exploits signal switching/mixing by connecting one or more signal inputs to one or more outputs, forming a multi-channel I/O format. Signals are added and mixed at the output connections. Different than the models for crossbar mixing and routing methods using menu-driven *send~* and *receive~* signal flow (as applied in the composer’ previous MSP composition *Lü)*, the object *matrix~* is employed in *Winter Landscape* for routing to optimize signal input, routing, processing, mixing, and output in a much more simple and flexible way. This application of *matrix~* has certainly resulted in CPU performance improvements.

Figure 5.2 *poly~ harm_tstretch_poly 8*



C. Capturing and Analyzing Live Instrumental Performance Data and Automation in MSP

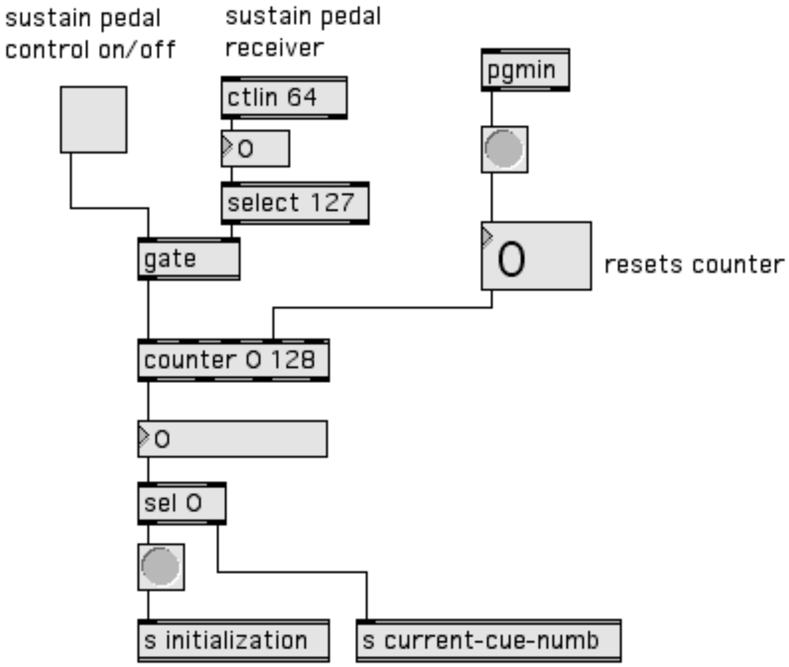
Capturing and analyzing live performance data is a technique that enables the computer to identify a variety of features of an audio signal. These features include discrete events such as the physical intensity, pitch information, harmonic component, note duration, and so on. The computer can also track continuous sample streams, such as the phrase length, the highest note/rhythm prevalence, etc. After detecting this information, the computer either triggers pre-programmed effect modules, plays back pre-processed sound files, or improvises based on the information acquired as discussed in Chapter 4. A discussion of the specific detection techniques incorporated in *Winter Landscape* follows.

Based upon the pitch and amplitude information derived from the *fiddle~* object, further detection of the phrase length (by determining the length of silences at the end of each phrase or detecting the approximate phrase duration along with silence length) and the most-often-played pitch/rhythmic pattern is possible. For a fully automated interactive piece (in which the computer follows the live musician's performance and advances its score by itself without the assistance of any external device), event detection is essential since it provides the premise and possibility for initiating interactivity as well as propelling the piece forward. Therefore, meticulous planning with the use of event detectors is extremely important for composers.

Each composer will have different event detection preferences while sometimes each unique composition will have different event detection needs. Despite these varying event detector possibilities and needs, a few common practices have proven practical and efficient. For instance, it would be efficacious for an interactive software programmer to use a pitch detector if specific pitch data is used to trigger and control events, to use a phrase detector when a phrase exceeds a regular length, to use note/rhythm prevalence detector when a characteristic pitch class set or rhythmic pattern is tracked, and/or to use an amplitude/attack detector when an easily perceptible loud signal drives the software. Composers will generally choose to use the event detectors that will best evaluate the incoming audio data to help guarantee the best detection of the unique musical materials in the score and most accurately respond accordingly without triggering false detections

Admittedly, an interactive piece with fully automated detection could demonstrate a composer's superb digital signal processing and MSP programming skill. However, most interactive works must account for the possibility of false triggers and will incorporate the assistance of a MIDI pedal or other MIDI device to help navigate through the composition. This also proves to be beneficial during rehearsal when the performer desires to freely skip certain musical phrases or sections for the purpose of practicing. As illustrated in Figure 5.3, a sustain pedal can be used to control a counter that progresses through a series of pre-programmed musical events. Through the object *select*, the musical event corresponding to the same *counter* number is triggered.

Figure 5.3 MIDI sustain pedal control as it appears in Qlist



In *Winter Landscape*, event detectors are combined with use of a MIDI sustain pedal. The MIDI pedal is used to move between larger sections (such as between rehearsal A and B in the first movement) while the event detectors are used to trigger events within each large section. This event detector use makes the sonic transformations from the effect modules as smooth and subtle as possible, thus avoiding the sudden drop and obvious distinction in sounds that frequently occurs when pressing the MIDI pedal. By limiting MIDI pedal use to triggering large sections, the performer is less distracted during performance and can provide a more free and expressive performance. Conversely, since the larger sections naturally have adequate silences placed between them and are usually contrasting in nature, the employment of a MIDI pedal would not cause an aural interruption.

Certainly, the choice of using either event detectors or a MIDI sustain pedal is left for each individual programmer/composer. However, as a generalization, event detectors can demonstrate a higher degree of artificial intelligence endowed to a computer and create the kind of complexity that listeners usually find engaging in human performance. Additionally, for a performer, event detectors offer greater freedom for him/ her to focus on the musical expressivity rather than technical concerns.

D. Spatialization in Stereo Environment

Spatialization is a term specific to electroacoustic music that refers to the sound process in which the location and movement of sound sources in physical space is carefully arranged and manipulated by the composer. From the perspective of the listener, spatialization signifies a sound process that animates the sound source within a three-dimensional environment.

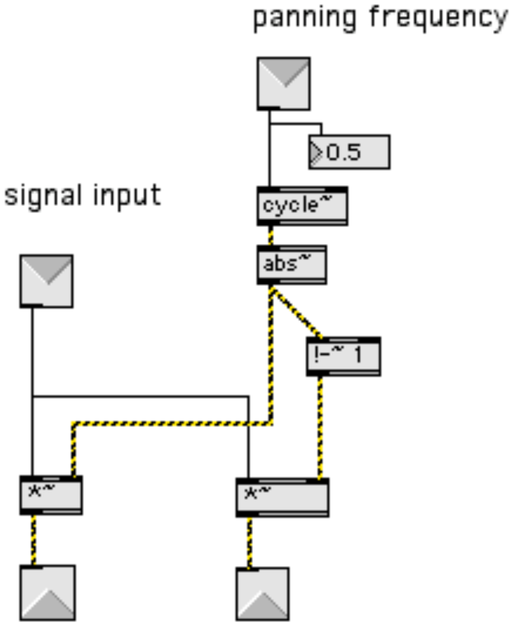
In electroacoustic music composition, spatialization has becoming one of the most significant compositional parameters (like melody, rhythm, or texture) for composers to consider. By incorporating various spatialization and digital signal processing techniques, a composer creates the illusion of sound moving even through a simple stereo playback system. Furthermore, spatialization can physically simulate a specific acoustic space, colorize the live sound, clarify multiple musical layers via spataial separation, reinforce the perception of multiple textures, and provide the perception of three-dimensional sound sources.

In order to spatialize sound in a stereo environment, the computer is assigned with specific algorithms to calculate the spatial points between the left and right channel (i.e., between the two speakers). The spatial points are then applied accordingly to the audio waveform in order to yield a spatialized waveform. When the spatialized waveform is played back from a pair of speakers, the sound appears to emanate from the chosen spatial point instead of the speakers. The audio waveform may be processed digitally in overlapping blocks of data using a Short-Time Fourier Transform. The localized sound may be further processed and combined with other effects, such as delay-based sound effects or room simulation to modify the sense of sound proximity.

In *Winter Landscape*, a variety of approaches have been adopted to create a moving acoustic environment instead of a discrete stereo playback. For example, the varied delay time transmitted to *tapin~* and *tapinout~* of the delay-based effect modules, such as *chorus* and *flanger*, naturally causes the sound to be played back from the two speakers with varying phase relationships, creating the illusion movement. An extension of this very idea is applied inside the subpatch *harm-tstretch-poly-8*. As explained in a previous Chapter, this poly-module distributes the incoming signal to 8 different channels for delay-based algorithms in order to generate a complex polyphonic texture. Since the 8 channels share the same motivic idea with random time delays, the resulting sounds are bounced back and forth between the two speakers, producing a sporadic effect.

Another application of spatialization is found inside the *harmonizer* module. In this instance, the processed signal is sent to the subpatch *autopanner* (Figure 5.4) which constantly changes the amplitude of each channel via the use of *cycle~* object, emulating a crossfade control of a waveform. As illustrated below, a gradual transformation of panning (the left channel gradually shifts to the right while the right channel shifts to the left simultaneously) is generated along with the harmonizing effect.

Figure 5.4 Auto Panner



Instead of passively accepting the panning parameters an effect module inherently generates, a composer needs to consciously consider and plan the employment of spatialization. In the case of *Winter Landscape*, localization of sound is applied in various sound effects and digital filters in order to enliven individual sonic detail. In addition, specific spatializations are intentionally manipulated to enhance the musical gesture. For instance, the potentially tedious repetitive notes pan gradually from one speaker to another with/without panning acceleration to creating a Doppler Effect, which serves as a means of animating and colorizing the sound source. It is also possible to combine spatialization with particular sound effects such as sound file granulation or looping to break the regularity and predictability of these processes. Through the gradual or random localization of the discrete sound a lively and engaging performance environment is thus simulated.

Conclusion

Since the middle of the twentieth century, electronic media have been used by many composers as a compositional tool and a new medium to convey their artistic ideas. With the rapid development of computer technology and web-based communication, electronic music has become one of the mainstream modalities in the academic composition field. As a result of the many recent technological developments, contemporary computer music has the potential to be quite refined relative to early electronic music.

These technological advances have given rise to the move from tape music to the evolution of many varieties of electronic music, including numerous works with interactive components that combine acoustic instruments with an artificial instrument—the computer. In a real-time interactive music performance system, the computer manipulates various algorithms to generate sounds through real-time audio analysis, data resynthesis, sound effects construction, physical modeling, and so on. In this manner, the computer demonstrates a high level of artificial intelligence by interacting with the human performer who plays a traditional musical instrument in real time. My composition *Winter Landscape* serves to demonstrate one particular approach to exploring the possibilities afforded in an interactive paradigm within a cross-cultural context.

A recurring theme in my work is the concept of 'balance of dichotomy': East vs. West, traditional vs. modern, and acoustic vs. electronic. In *Winter Landscape*, this theme is revisited through the utilization of the computer music programming language Max/MSP. With my professional training in Chinese music and western music, I have strived to express my individuality and personality through my music and have searched for a balance between traditional (Eastern) and modern (Western) sounds.

The influences of Chinese philosophy (especially *Chán*) and the essence of Chinese traditional music play a prominent role in my thinking, as demonstrated in the formation of structures, expressions, and the concept of *Yun* in the work. Similarly, these influences play a great role in determining the instrumentation and basic pitch structures of the work. Nonetheless, this work is equally influenced by techniques and practices of modern Western classical music. It is hoped that these diverse influences have resulted in a unique work that truly represents a cross-synthesis of these varying influences.

In *Winter Landscape*, the interaction that takes place between the computer and the live musician is intended to reveal the responsive human/machine relationships. The computer constantly shifts its roles as a musical instrument, conductor, performer, and improviser to facilitate the sonic realization of the solemn, nebulous, and peaceful nature of *Chán* philosophy, thus exploring the cultural and musical potentials; meanwhile, the design of algorithmic structures simulate the modeling of human performance, enabling the computer with intellectual ability and musical expressivity as a decision-maker, resembling its counterpart—the live performer.

From a technical perspective, composing a work that incorporates interactive computer music requires the composer to come up with creative solutions that will address the specific needs of an individual composition. Some of the technical solutions that are incorporated within *Winter Landscape* will hopefully be useful for other composers who are working within an interactive paradigm. The programming strategies for event detection, CPU efficiency, and sound spatialization have proven to work effectively in *Winter Landscape*.

A. The Composer's Future Plans on Interactive Composition

Given my educational and musical background, as well as my experience working within the profession, my focus in the composition field has naturally continued to explore the interaction (using Max/MSP) between the computer and live musical instruments (especially Chinese traditional music instruments), along with computer-based control of multimedia. I strive to endow Chinese instruments with contemporary color through the use of technology, which in turn will hopefully contribute a distinctive stylistic addition to western music. In most of my interactive compositions, the computer is intentionally designed and utilized as a musical instrument with its unique/diverse timbre and versatile performing techniques interacting with other live musical instruments.

B. Methods and Stages of the Composer's Interactive Composition

My work to date has raised a number of issues and concerns that I would like to explore further. First, the unique construction and tone color of Chinese musical instruments can provide a useful addition to the western instrumental family. These unique qualities require further development of corresponding analysis and synthesis/resynthesis techniques applied to real-time processing. Consequently, I plan to review extant computer music analysis/synthesis techniques including, but not limited to, digital audio processing, spectrum analysis, and resynthesis techniques. I will also focus on specific filtering techniques, as well as developing virtual instruments through FM synthesis to create ever-changing timbres that simulate the Chinese musical instruments erhu and guzheng.

Computer music notation is another field I intend to further explore. Specifically, I hope to better address the problems one encounters when notating the synchronization of the computer with acoustic instruments, and diffusion-related notation.

I am also very interested in expanding my cross-cultural explorations to embrace a variety of new media technologies and traditional art forms in an effort to find new modes of expression. Consequently, the combination of music with video, real-time interactive pieces integrating music and video, and the real-time or fixed coordination of music, text, and images are all areas I intend to explore.

Expanding upon the digital signal analysis and resynthesis techniques applied in my Max/MSP interactive music systems, I will explore the compositional possibilities of combining audio with video in a real-time setting, do further study on the software Jitter, and integrate acoustic instruments and Max/MSP with Jitter to undertake interactive audio/video compositions. I anticipate that the technical and aesthetic relationship among real-time art forms will be the focus of my composition and research in the near future. I also hope to work closely with other artists to explore the artistic possibilities of multidimensional interactive art.

In summary, *Winter Landscape* serves as an attempt to broaden my vision and knowledge of interactive and cross-cultural composition. My mission with this work has been to convey my personality and identity as a contemporary Chinese composer through diverse cultural and musical influences drawn to this particular piece while creating a balance between traditional and modern sounds. Concurrently, I strive for creative solutions to technical problems encountered in the process of composing for this interactive paradigm. I always hold the belief that a composer should let his/her music speak for itself and call for an attitude that requires not only audiences' aural attention but their intellectual and spiritual involvement as well. Hopefully, this very belief permeates *Winter Landscape* thoroughly and profoundly.

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PART II:

WINTER LANDSCAPE

(FOR FLUTE, ERHU, PIANO, AND COMPUTER)

Winter Landscape

(for flute, erhu, piano, and computer)

(2008-09)

by *WANG, Jing*

Movement I: A sprinkle begins to fall...
Movement II: Little dances of the snowflakes
Movement III: Snow spell

Duration: Ca. 15’

Program Notes

Winter Landscape

(for flute, erhu, piano, and computer)

Winter Landscape is an interactive composition for flute, erhu (Chinese two-stringed fiddle), piano, and Max/Msp interactive computer music system.

Snow was chosen as the subject because the artistic concept that snow conveys reflects the Chinese philosophy of *Chán* (the Japanese pronunciation is *Zen*). The purity, cleanness, uniqueness (in shape), tranquility, and brightness of snow echoes the beauty of *Chán* philosophy—solemn, nebulous, elegant, and peaceful, as well as the essence of *Chán*—integrating "have" with "have not" (emptiness), and "motion" and "motionlessness." The ultimate goal of studying *Chán* is to attain the state of the unity between "universe" and "self" and perfect peace, or nirvana. As a result, the snowy landscape illustrates *Chán*'s spirit in many ways.

The three-movement piece, *Winter Landscape*, is intended to depict a Chinese snow scene accompanied by the composer's artistic conceptions of snow through music. Three movements, each based upon an ancient Chinese verse respectively, are titled: I)"清" (*A sparkle begins to fall…*), II) "舞" (*Little dances of snowflakes*), and III)"悠" (*Snow spell*). "清" delineates the smoky and foggy landscape created by the snow, "舞" emphasizes the floating motion of the snow to illustrate its ethereal beauty, and "悠" portrays a large picture of the "white world" covered by the snow. These three snow scenes will be presented in music through different textures, timbres, and temporalities.

Performers' Note

Symbols and Abbreviations:

1)  – The repetition of previous music event (boxed pattern) goes to next music event without stop.

 – Interpret vibrato according to the suggested wavy line.

2) S.V. – senza vibrato

molto vibr. → S.V. – play *molto vibrato* and gradually change to *senza vibrato*

S.V. → molto vibr. – play *senza vibrato* and gradually change to *molto vibrato*

3) The notated multiphonics signify the desired sonic result. If the multiphonics cannot be produced due to certain circumstances, the flutist may choose to play the highest single note instead.

WINTER LANDSCAPE

I: A sprinkle begins to fall...

Jing Wang
2008-09

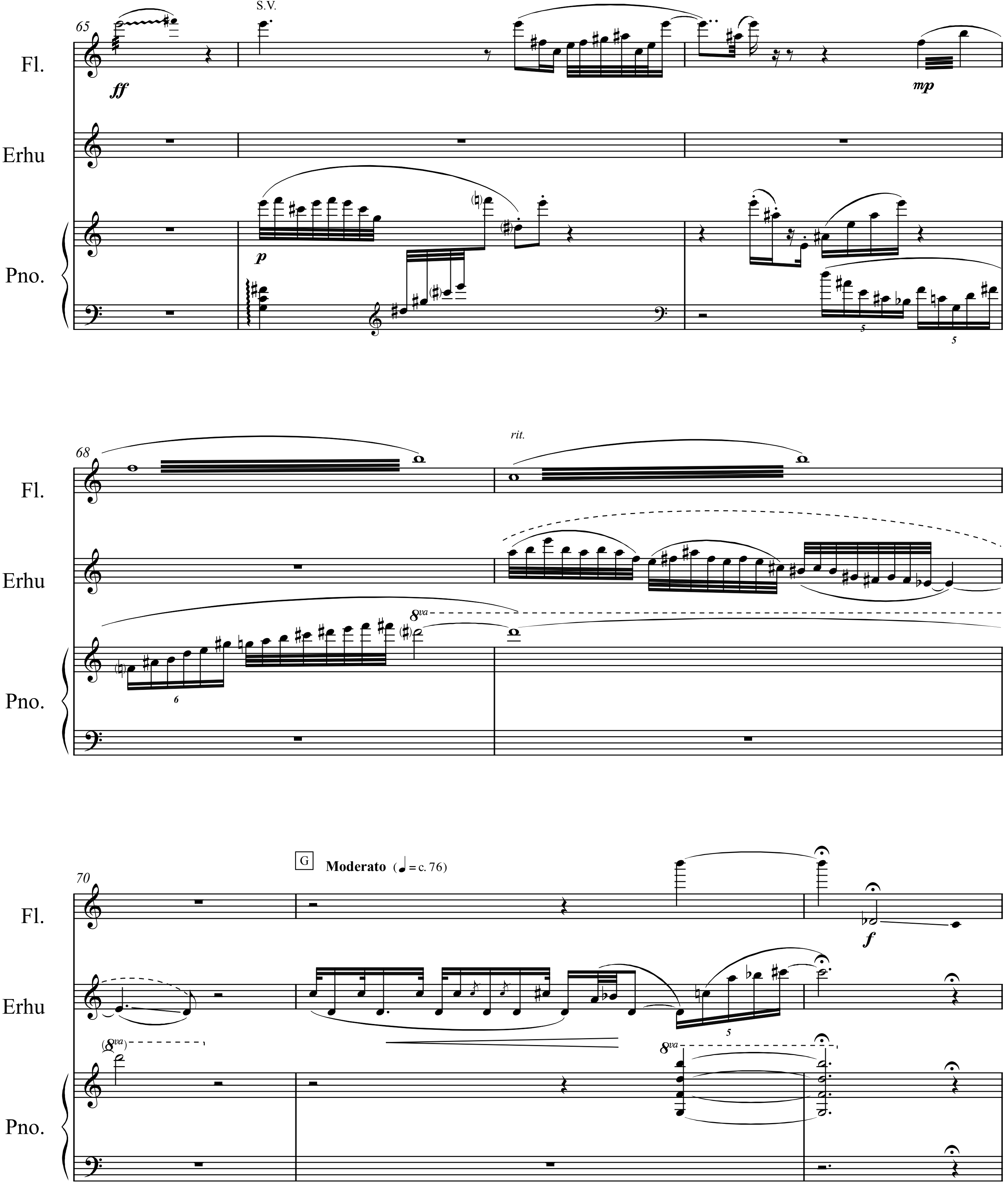

11
molto vibr.
S.V.
S.V.
molto vibr.
B
pp
pp
Fl.
Erhu
Pno.
16
Moderato (♩ = c. 76)
mp
8va
mp
3
6
20
(8va)
mf
3
3
p
f
6
3


C
Moderato (♩ = c. 108)
24
Fl.
Erhu
Pno.
mf
mp
3
5
27
p
30
mp
mf
S.V.


D
33
Fl.
Erhu
Pno.
f
36
8va
mf
p
40
(8va)
mp

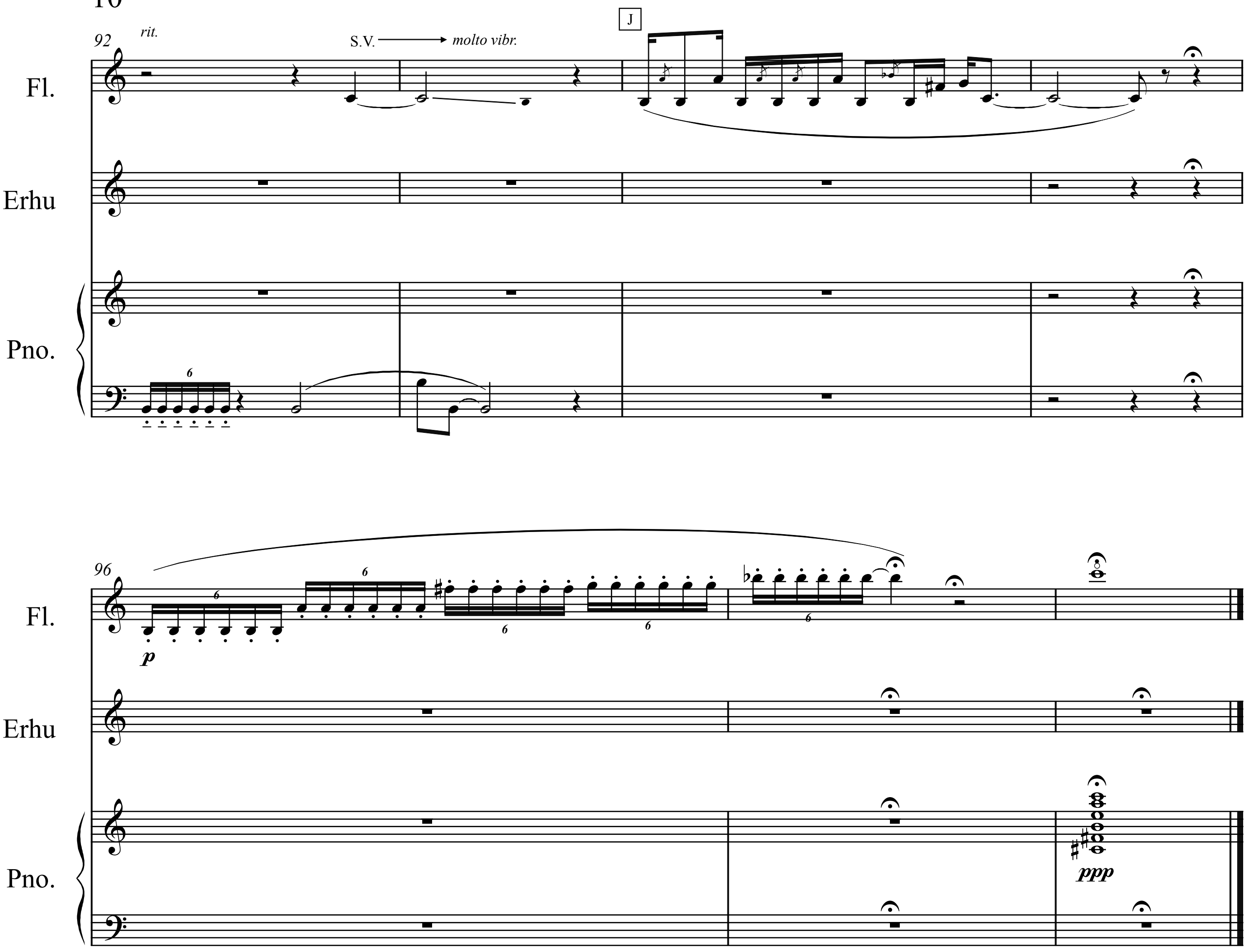

43
Fl.
Erhu
Pno.
p
mp
46
repeat the boxed notes/patterns in a fast and irregular way
E
overblow into harmonics
freely sweep the inner strings of the piano
50
f


54
Fl.
Erhu
Pno.
6
7
mf
3
58
furioso
fff
8va
8vb
61
F
5


65
S.V.
Fl.
ff
mp
Erhu
Pno.
p
5
5
68
rit.
6
8va
70
G
Moderato (♩ = c. 76)
f
(8va)
8va
5


73
S.V.
molto vibr.
Fl.
Erhu
Pno.
75
tr
accel.
a tempo
H
79


82
Fl.
Erhu
Pno.
85
I
mp
mf
mp
88
6
p
pp


92
rit.
S.V.
molto vibr.
J
6
96
p
ppp
Fl.
Erhu
Pno.

II: Little dances of the snowflakes

2008-09


10
Fl.
Erhu
Pno.
mp
mp
13
B
17


21
Fl.
Erhu
Pno.
6
3
R.
L.
pp
24
ff
mp
mf
28
p


32
Fl.
Erhu
Pno.
mf
p
6
3
hit the wooden body
on the piano
C
35
5
mp
mf
38


D
the flute and erhu play as a group and do not need to be synchronized with the piano
41
Fl.
Erhu
Pno.
hit the wooden body on the piano
p
pp
45
48

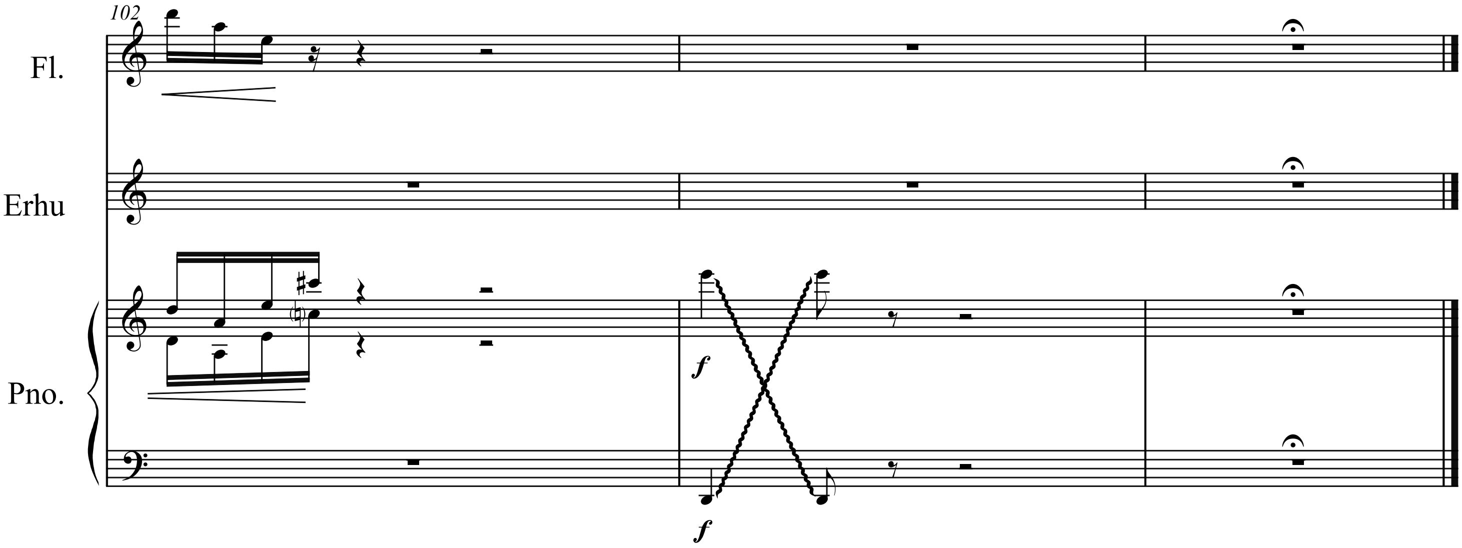

52
Fl.
Erhu
Pno.
55
E
pp
mf
58
mp
3
5
6


61
rit.
F
a tempo
pp
pp
Fl.
Erhu
Pno.
6
65
p
p
69
8va
2
mp
pp


73
Fl.
Erhu
Pno.
pp
mf
8va
77
(8va)
81
mp
p
mp
pp
mf


G
84
Fl.
Erhu
Pno.
mp
6
87
H
90
mp

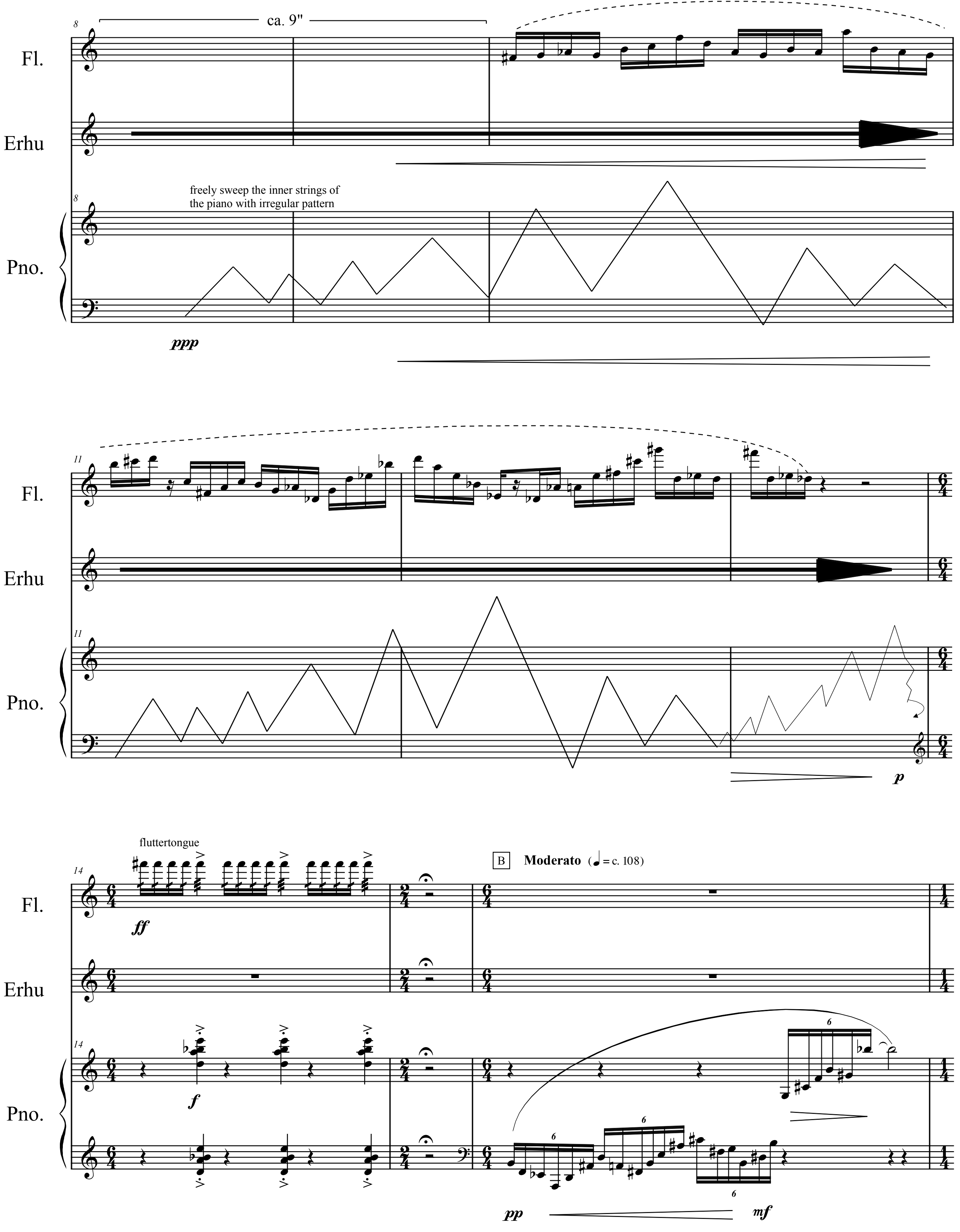

93
Fl.
Erhu
Pno.
R.
L.
6
Gliss
96
rit.
a tempo
3
99
mp
pp

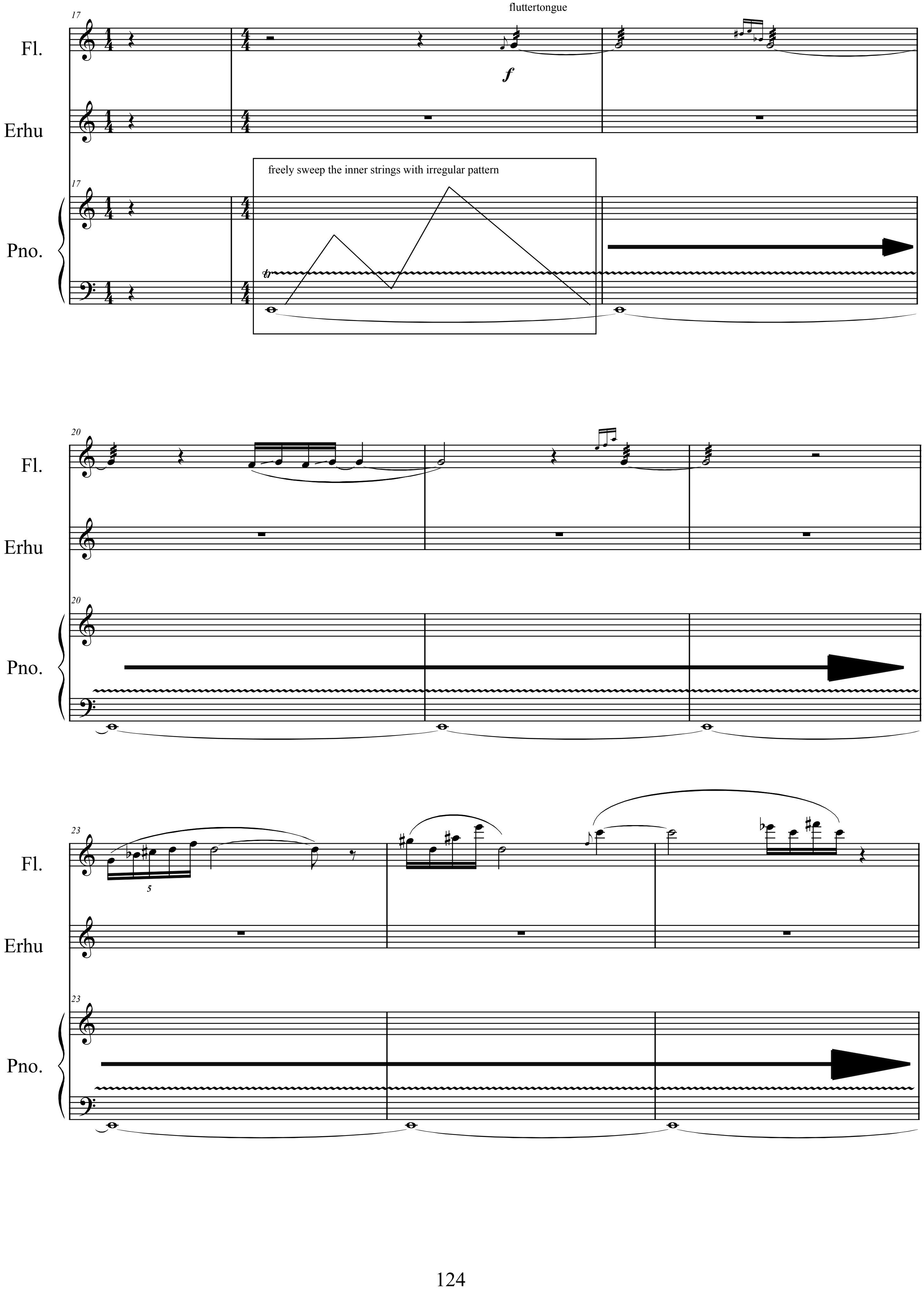

102
Fl.
Erhu
Pno.
f
f

III: Snow spell

Agitato Allegro (♩ = c. 150)

2008-09


8
ca. 9"
Fl.
Erhu
8
freely sweep the inner strings of the piano with irregular pattern
Pno.
ppp
11
Fl.
Erhu
11
Pno.
p
14
fluttertongue
Fl.
ff
Erhu
14
Pno.
f
B
Moderato (♩ = c. 108)
6
pp
mf

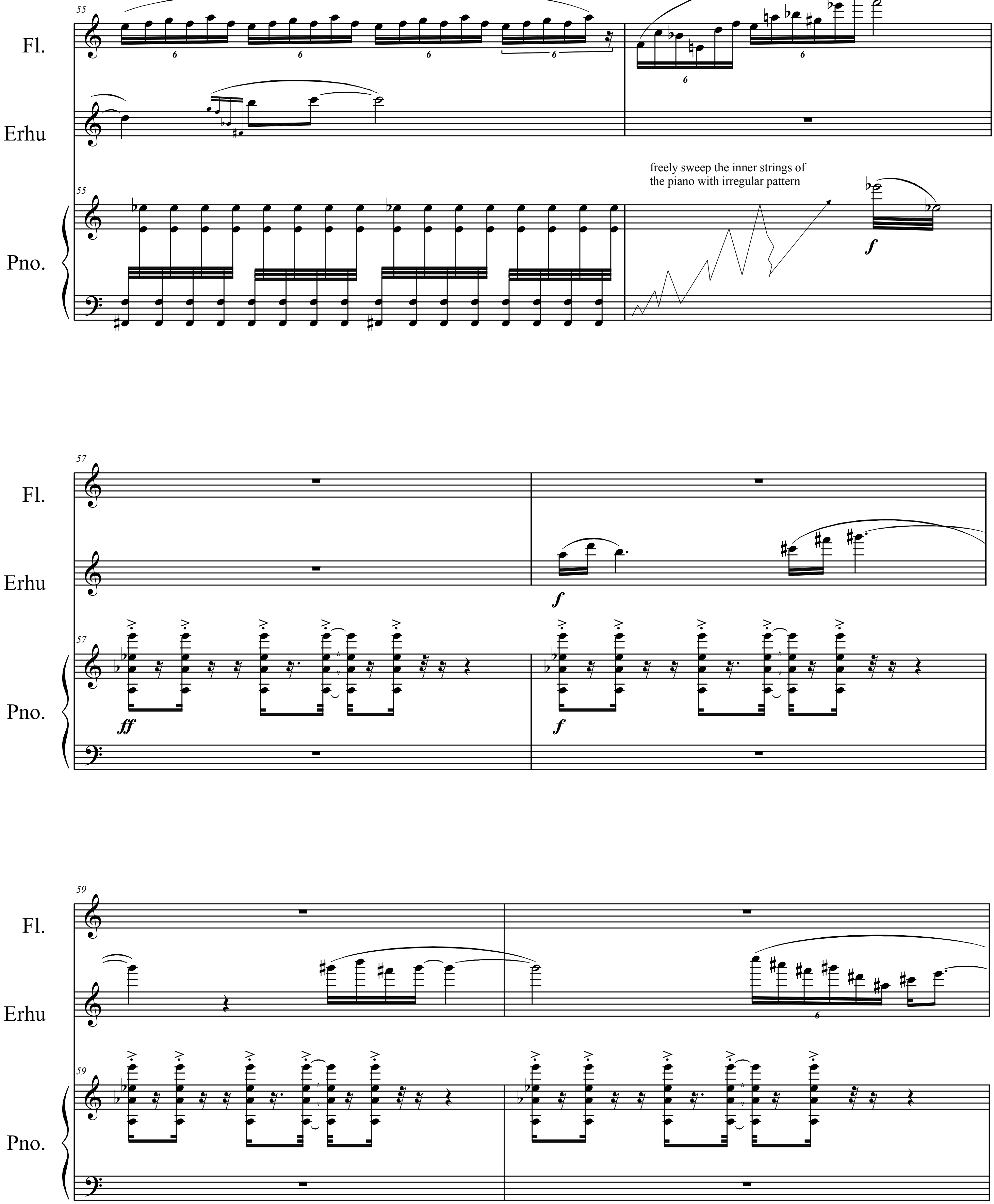

17
Fl.
Erhu
17
Pno.
fluttertongue
f
freely sweep the inner strings with irregular pattern
tr
20
Fl.
Erhu
20
Pno.
23
Fl.
5
Erhu
23
Pno.


Fl.
Erhu
Pno.
26
mf
mp
6
5
29
32
p
2
4
5
4
tr


Fl.
Erhu
Pno.
35
36
37
38
39
40
mp
f
mf
6


41
Fl.
Erhu
Pno.
f
44
accel.
ff
tr
a tempo
47
mp
mf
2/4
6/4

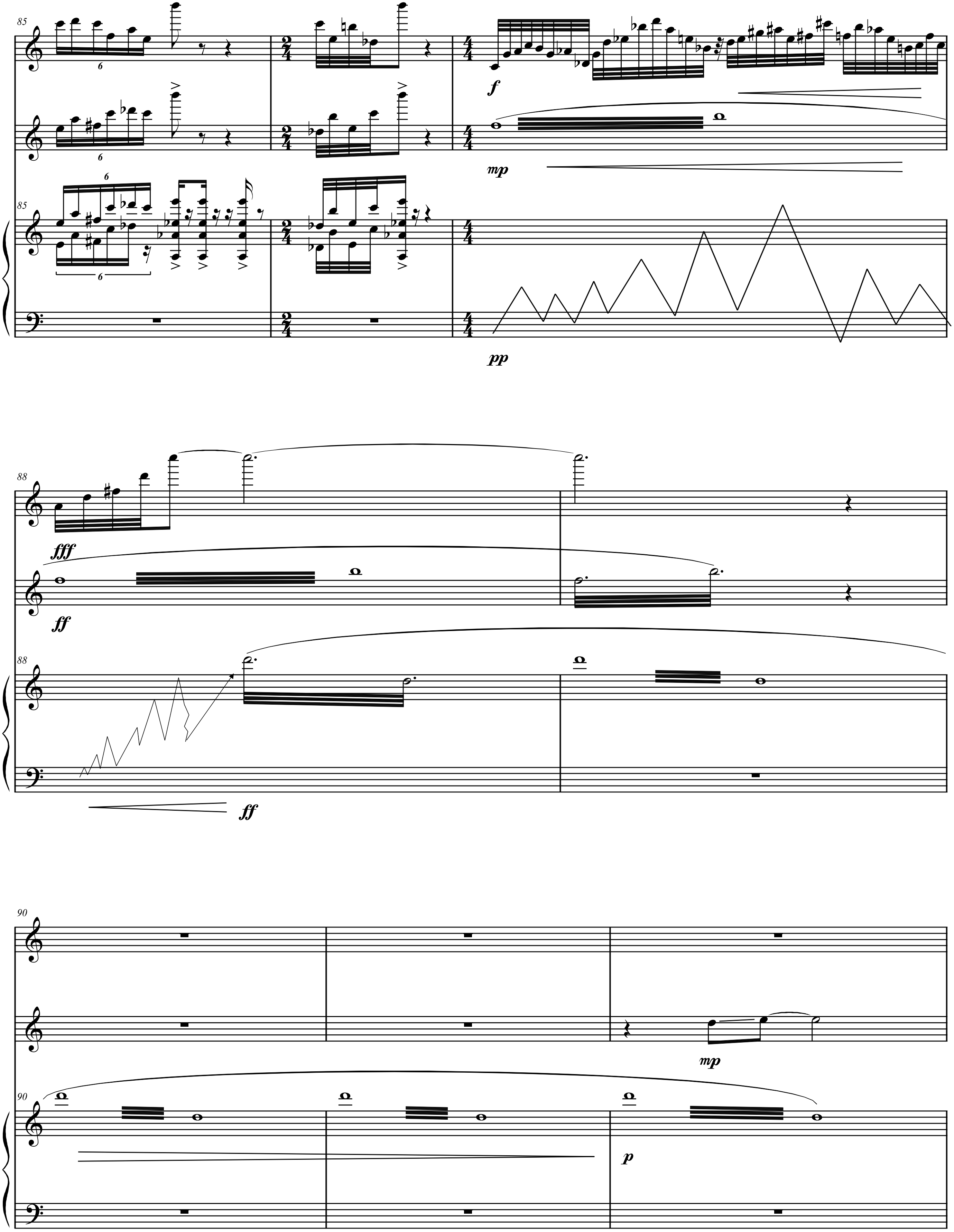

C
49
Fl.
Erhu
Pno.
15mb
p
ff
mf
6
51
mp
53


55
Fl.
Erhu
Pno.
6
freely sweep the inner strings of
the piano with irregular pattern
f
57
ff
f
59


61
Fl.
Erhu
Pno.
mf
6
f
63
65
tr
hit the inner strings with palm


67
Fl.
Erhu
67
Pno.
70
Fl.
Erhu
70
Pno.
73
Fl.
Erhu
73
Pno.


76
Fl.
Erhu
Pno.
79
mf
ff
82
Fl.
Erhu
Pno.


85
Fl.
Erhu
Pno.
6
f
mp
pp
88
fff
ff
ff
90
mp
p


93
Fl.
Erhu
Pno.
mp
5
96
99
3
3


102
Fl.
Erhu
Pno.
pp
pp
3
3
rit.
pp
105
a tempo
6
6
6
f
108
ff
f
hit the inner strings of the piano with palms
fff