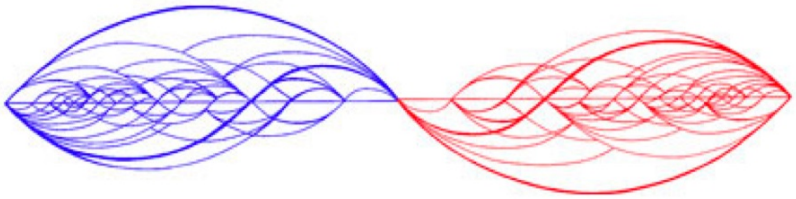

The Holomovement of Music :

Unfolding Music, A Look at Holomovement and Composition.

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Chapter 1

Introduction

The world can be described as being both material and immaterial. A material is a physical substance including natural entities and man made synthetics that we can measure and sense, and immaterial is those that exist and are describable, but not physically sensible such as feeling and thought. Physicist David Bohm was interested in the relationship between them and the way the state of the physical and intangible world can be exchanged. He was an expert scientist in quantum physics, but in his late period he became focused on the interaction between two different states. The Holomovement theory is one of his representative researches that talks about the relationship between physical representation and its hidden order behind, and how they are connected to each other and create a movement. In his theory it is demonstrated with the Enfolding/Unfolding orders and their creation as a whole.

Music is related to both areas since it is a human expression from an immaterial state, and throughout a material state such as sound and space, it is converted into the immaterial state in the audience again. In this changing moment, a meaning, information, feeling, or aesthetic toward an issue is included and carried together with sounds. When looking deeper into music and its way of creating/processing sounds, there are a number of different states by exchanging two different states from an abstract level to a concrete one. This thesis first of all is to observe how music can be seen with the Holomovement theory especially in the field of electronic music. It includes analyses in the Holomovement point of view of several pieces of music by other composers, which give a new way of approaching to newly experiential possibilities. Furthermore, it contains the application of the theory to music composition of my own, based on the belief that moving toward a new way of thinking through a scientific, metaphorical view will offer a chance to expand thoughts of composing sounds and music.

Curtis Roads in *Microsound* started talking about the micro level of sound comparing with quantum mechanics. However, the quantum theory was not the one that is

scientifically affected on his theory or directly related to it, but it could help him to consolidate his point of dealing with the micro level of sound and its organization in terms of understanding.

György Ligeti was one of those who were fascinated by modern mathematics and physics. Natural science and its phenomena were the resources of his model for contemporary thinking-processes and patterns which have simulated comparable but different processes in his music. (Steinitz, 1996) His 15 Études for piano are based on the idea of the Chaos theory in order to generate a complexity especially in rhythm. However, different from other composers such as Xenakis, who actually used statistics and probability as the formulation of his musical creative processes with its calculations and proportion, Ligeti's music is neither controlled by mathematical rigor nor computation, but is the exploration and the result of his interest in mathematical ideas and their captivation.

Similar to the relation of Ligeti to his interest toward a specific theory in other fields, the Holomovement theory has given not only a new way of composing sounds and processing them with unlike musical ideas, but also different possible ways of listening to and experiencing music that is already known and analyzed with existing and familiar terms. Accordingly it is not a scientific representation for processing parameters and musical structures by a certain formula, but for applying its own characteristics in a possible way as it has a particular principle dissimilar to the classical point of worldview. It is an *inspiration* toward the *aspiration* to look for an extraordinary way of experiencing all musical activations through the new orders in the Holomovement theory, and it is a starting point to go further into a new way of generating sounds and their composition.

Chapter 2

The Holomovement theory by David Bohm

"One is led to a new notion of unbroken wholeness which denies the classical idea of analyzability of the world into separately and existing parts ... We have reversed the usual classical notion that the independent 'elementary parts' of the world are the fundamental reality, and that the various systems are merely particular contingent forms and arrangements of these parts. Rather, we say that inseparable quantum interconnectedness of the whole universe is the fundamental reality, and that relatively independent behaving parts are merely particular and contingent forms within this whole."(Bohm 1975)

2.1 Background

David Bohm(1917-1992) was one of the authorities on quantum physics in his generations and presented a new phase of quantum theory. Bohm taught at Princeton University and worked on plasmas, theory of metals, quantum mechanics, and elementary particles, and was one of the members of the Royal Academy in England, the originator of the causal interpretation of quantum theory,

In his books *Unfolding meaning*, and *Wholeness and Implicate order*, he talks about quantum theory and theory of relativity with differences from the mechanic worldview in classical physics, incomplete factors included in both theories and problematic to become a total explanation of everything. To sum up of his view, the theory of relativity requires strict continuity, determinism, and locality. In quantum mechanics, however, it needs discontinuity, uncertainty, and non-locality. Nevertheless, there also is a certain coherent point to see the universe as an unbroken wholeness. (Bohm 1985) Each has this wholeness in a different way, and it leads to the needs of a new order in physics for thinking about the basic nature of the universe as an unbroken wholeness, which is different from mechanism. Then, he built a new theory called '*holomovement*.' There are critical points below about the view of world that are suggested by Bohm and should be considered to grasp the main idea of the holomovement theory.

- All existence in universe including objects, human beings and their consciousness cannot be regarded as separate parts.
- Therefore everything moves together and forms the whole.
- What makes it possible is a new order, and it causes the motion of objects and the whole universe to be analyzed differently from classical mechanism.
- According to that, every part of the whole includes all information of the whole.

When this theory came out, it affected the whole of physics, gave a new impression to look at the worldview, and became the important notion of several different fields, such as neurology, sociology, psychology, etc. The theory includes new orders, which are the critical components of the Holomovement; the Enfolding and Unfolding order. To understand the meaning of the new orders and the Holomovement theory, some representative examples suggested by David Bohm will be showed with detailed explanation.

2.2 Hologram Model

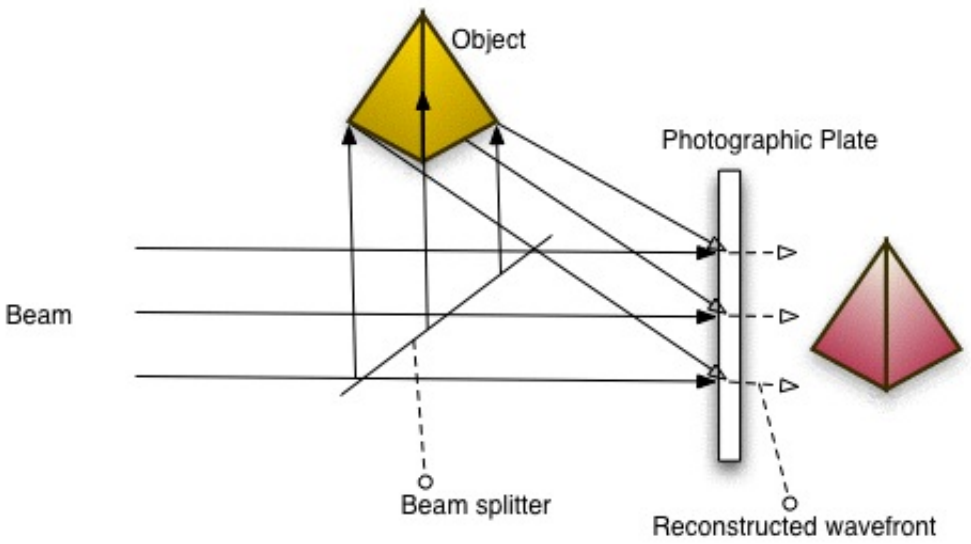

Figure 2.1: Holographic principle

The Figure 2.1 shows the holographic principle invented by Dennis Gabor(1900-1979, London). The principle is as follows: light from the laser beam is passed through the beam splitter(half-silvered mirror). A part of the beam illuminates the object while the other part goes directly to the photographic plate. When the light is reflected off

the objects with the reference beam, an interference pattern is created, and this pattern is recorded on the photographic plate. When a photographic image of the interference pattern called *hologram* (Figure 2.2) is illuminated by the laser beam, the interference pattern of the hologram plate is unfolded in a space, and a three-dimensional image of the original object is formed. This is the way of building a three-dimensional graphical image of an object.

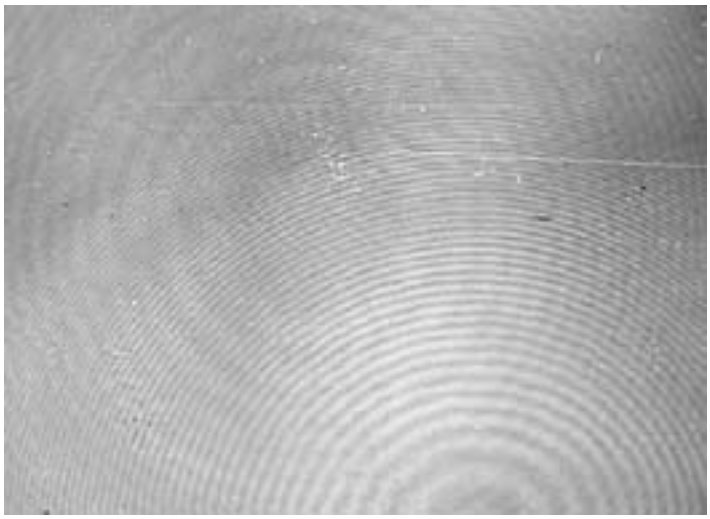

Figure 2.2: Hologram

Likewise, the hologram itself is a fixed photograph of a recorded wave motion taken in a certain moment. What is shown in the hologram is not a normal object-like figure, but an interference pattern engraved by the wavelength of light. In each region of the hologram, the movement of the light implicitly contains a vast range of distinctions of orders and measures, appropriate to the whole illuminated structure.

About hologram, David Bohm describes about interference pattern:

> *'In subtle sense, which does not appear in ordinary vision, the interference pattern in the whole plate can distinguish different orders and measures in the whole illu-*

> *minated structure. For example, the illuminated structure may contain all sorts of shapes and sizes of geometric forms as well as topological relationships, such as inside and outside, and the intersection and separation. All of these lead to different interference patterns, and it is this difference that is somehow to be described in detail.' (Bohm 1973)*

The important issue is that when a light illuminates any part of the hologram plate, the original three-dimensional image appears. If just a small amount of light illuminates very small part of the hologram, the reconstructed image is faint, but one can still clearly find the figure of the original object. This means that every part in the interference pattern *enfolds* or remembers all information of the object, and through using a certain medium such as light, the whole can be *unfolded.*

2.3 Ink-to-Glycerin experiment

Bohm represented another example to support his Holomovement theory with the insoluble ink and a viscous fluid, glycerin. There is a jar filled with glycerin, and in the center of the jar there is a cylinder rod with a handle so you can turn the handle. Now, one drops a droplet of the ink into the jar, slowly turns the inner cylinder with the handle to one direction and can see that the droplet is spread into the glycerin. If it is continuously being turned, the ink is drawn out into longer, ever finer and fainter lines. Eventually, with keeping turning this, the ink actually disappears completely. It can no longer be seen.

Now at this point, it is very tempting to conclude that the order that was originally present in the drop has now been rendered completely random and chaotic by thorough mixing of the ink into the glycerin. So much so that one can no longer even see the ink. However, if the direction of rotation is now reversed, what one can find is that

a thin long line of ink will begin to reappear. As turning continuously with the reversing rotation, it will continue to get thicker and more clearly defined, and eventually, it will completely reconstruct itself.(Figure 2.3)

This is a mechanical metaphor for what Bohm talks about. Bohm called this order the Enfolding order, because although the ink is dispersed to the point of not being visible, its order has, in some way, been preserved. Or, it has been transformed into a different form, but it has not been destroyed. It can then move from being enfolded into what Bohm would call the Unfolding order, where the order has been made visible and made manifest. There then is this ink dot reappearing. When the ink drop disappears, Bohm would say that its order is enfolded in the glycerin. When the ink droplet reappears, its order is unfolded back into the Unfolding order.

Figure 2.3: Ink-to-Glycerin experiment

2.4 Enfolding and Unfolding order

"There is the germ of a new notion of order here. This order is not to be understood solely in terms of a regular arrangement of objects (e.g. in a row) or as a regular arrangement of events (e.g.in a series). Rather, a total order is contained, in some implicit sense, in each region of space and time."(Bohm 1980)

In the above example of the hologram model, each region in the hologram plate enfolds all information, and it makes possible to recreate the figure of the original object in three dimensions. Also in the ink-to-glycerin experiment, during the process of stirring glycerin, the time and space order of the movement of ink droplets are preserved so that when reversing the direction of stirring, each ink droplet reappears. Likewise, what is engraved in the hologram plate, and what is enfolded during the stirring motion can be regarded as an example of *the Enfolding order* that includes all information of the whole, and *the Unfolding order* makes it possible to perceive the whole structure.

Bohm suggests that in some sense each region contains a total structure *'enfolded'* within it as one sees in hologram model and ink-to-glycerin experiment, and he uses the term, *'Implicate order.'* here, it will be called **'Enfolding order.'** The word 'implicit' is from the verb 'to implicate' which means *'to fold inward.'* Then, what is in this order can be presented by *'Explicate order'*, also called **'Unfolding order.'** The word *'explicit'* has the opposite meaning to the word *'implicit,'* which is *'to unfold outward.'* The Unfolding order is the result of unfolding the Enfolding order and shows what the Enfolding order includes, such as the three-dimensional recreation of the object in the hologram model, and the reappearing ink droplets.

Consider a process of a conversation. People use their own languages to express their thought or feeling. What is coming out from their mouth is just a series of sounds created by a certain order of sounding letters. However, since each sound is referring to a word, which includes a meaning inside, people are able to deliver their thought to each other, and this process is called a conversation. If someone does not totally understand the meaning of any word coming out from the other, each sound is nothing but just a sound. Without the enfolded meaning of the word, its sound, there can be no communication achieved. Then, it is possible to consider the meaning of word as an Enfolding order, which includes information (e.g. feeling and thought), and when

it becomes a sound through one's mouth, it can be considered as an Unfolding order, which we can perceive because of the physical activity.

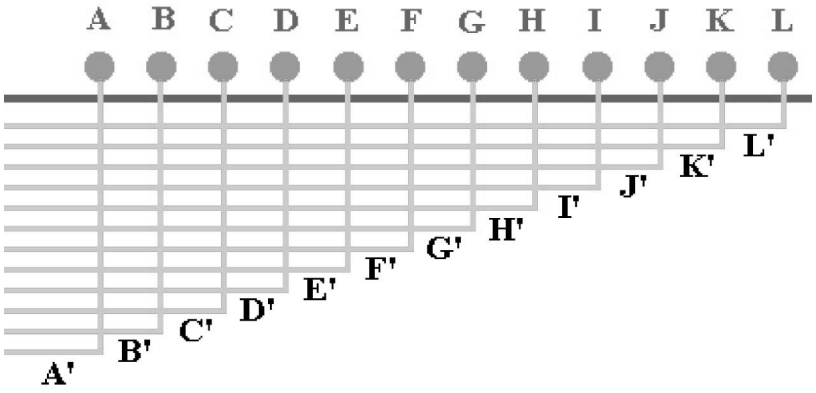

Figure 2.4: The hierarchical Enfolding order under the surface of Unfolding order

The Unfolding order is the order that we directly perceive. In figure 2.4, the latters A, B, . . . , L represent an array of the Unfolding orders in reality that are consequences by the Enfolding orders below (A',B',. . . ,L') Bohm thought that there is an infinite hierarchy of the Enfolding orders above the Unfolding order. Bohm suggests that the Enfolding order directly above the Unfolding order of the observed matter contains the physical laws, which govern the motion of the matter. **They are implicit in the Unfolding order. Accordingly, they are not directly observed but must be inferred from measurement and observation.** The Unfolding order in general is referred as the laws of physics. The things that one can see, hear, smell, touch, and measure can be considered as the representation of the Unfolding order.

2.5 Definition of Holomovement

From these considerations, Bohm was led to the idea of the *Holomovement*, which *'carries'* the Enfolding order and which, because of enfoldment, is **an unbroken and**

undivided totality. (Bohm 1980) *'Holo'* is from the Greek word meaning the whole, and in this context it represents an 'unbroken totality.' 'Hologram' merely means to write the whole. David Bohm suggests that this movement of carrying Enfolding order is never ending since the Enfolding order is successively carried by the Holomovement under what is unfolded, and this Enfolding order constantly changes and the Enfolding and Unfolding order cannot be explained separately.

Bohm compares the holomovement with the process of the growth of a plant. Imagine a seed of an apple tree. The seed already has all information to grow up with the aid of the sun and water, and the state of each moment from the seed and the sprout to the tree is continuously changing, which is hard to be observed according to its slow processing time. However, there is an ordered, structured inner movement that causes it to change its state slowly and successively. With a certain amount of time, the altered state can be noticed with differences from the state of seed. From the holomovement point of view, the Enfolding order can be the DNA information the seed includes in which we cannot perceive without a type of analysis, and the Unfolding order can be what we observe, such as a seed, a sprout, flowers, branches, and apples. The Holomovement is the one that makes it possible for the seed to be able to change its state and grow up. It is not observable without a special analysis or method, but is there to give rise to all the changes of each state, which also can be considered as a flowing undivided unbroken movement as a whole.

2.6 Movement in Holomovement

At this point, it is better to clarify the meaning of movement in terms of the Holomovement and the difference from what we consider as a movement in general. In above example of the apple tree, it seems problematic to understand the meaning of movement since it shows only 'inner changes' in a certain amount time but the whole

process happens in one place. One would say that the inner change is metamorphic so that it is hard to consider it as a movement. Following examples will explain the differences of the definition of movement.

2.6.1 Listening process as an Enfolding/Unfolding process

Let us think about what is happening during the listening process. When we listen to music, each of vibrating sound comes into the ears from a sound source such as a violin, a choir, etc. It is clearly not a simple journey of sounds from the body of the instrument to the ears through the air. When we perceive each sequence of notes and a mass of sounds to a certain structure or form as a piece of music, there is a certain process with our consciousness. More closely looking into the process, at a given moment a certain note is being played but a number of previous notes are still 'reverberating' in consciousness. It is a simultaneous presence and activity of all these reverberations that is responsible for the direct and immediately felt sense of movement and continuity.

It is sure that we do not experience the actuality of this whole movement by 'holding on' to the past with the aid of a memory of the sequence of notes, and comparing this past with the present. Rather the 'reverberations' that make such an experience possible are not memories but are rather 'active transformations' of what came earlier, in which are to be found not only a generally diffused sense of the original sounds, with an intensity that falls off, according to the time elapsed since they were picked up by the ear, but also various emotional responses, bodily

sensations, incipient muscular movements, and the evocation of a wide range of yet further meanings, often of great subtlety. (Bohm 1980)

Accordingly we can obtain a direct sense of how a sequence of notes is enfolding into many levels of consciousness, and of how at any given moment, the transformations flowing out of many such enfolded notes inter-penetrate and intermingle to give rise to an immediate and primary feeling of movement. In music, many different but interrelated degrees of transformations of ensembles are sensed immediately as the presence together of many different but interrelated degrees of transformations of tones and sounds. There is a feeling of both tension and harmony between the various 'co-present' transformations, and this feeling is indeed what is primary in the apprehension of the music in its undivided state of a flowing movement.

Likewise David Bohm says that while listening to music one is therefore directly perceiving an Enfolding order. This order is active in the sense that it continually flows into emotional, physical, and other responses, that are inseparable from the transformations out of which it is essentially constituted.

At this point, it is necessary to think about what is actually happening in our nerve system and brain when we perceive sounds. One would think that it sounds somewhat vague that the enfolding process is happening in consciousness.

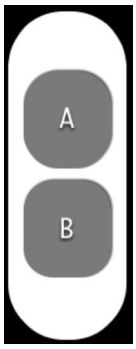

Figure 2.5: A light bulb including two disks

2.6.2 The sense of flow

Imaging two disks A and B. and they are enclosed in a light bulb.(Figure 2.5) Those two can be caused to give off light by means of electrical excitation. The light is made of flash on and off so rapidly that it appears to be continuous. Now think about the case in each flash it is arranged that B will come on slightly later than A. What one actually feels is a sense of flowing movement of light between A and B. However in reality nothing is flowing out of B. A sense of flowing movement is experienced when, on the retina of the eye, there are two images in neighboring positions one of which comes on slightly later than the other.

What we can understand from this experiment is not the actual movement itself since there is no flowing movement at all. Nevertheless we certainly feel that light is moving from A to B. In terms of Enfolding order, this can be considered as a movement, and the sense of flow is the direct experience of the Enfolding order.

2.6.3 Movement in reality

We might still have some confusion between what we consider actual movement.

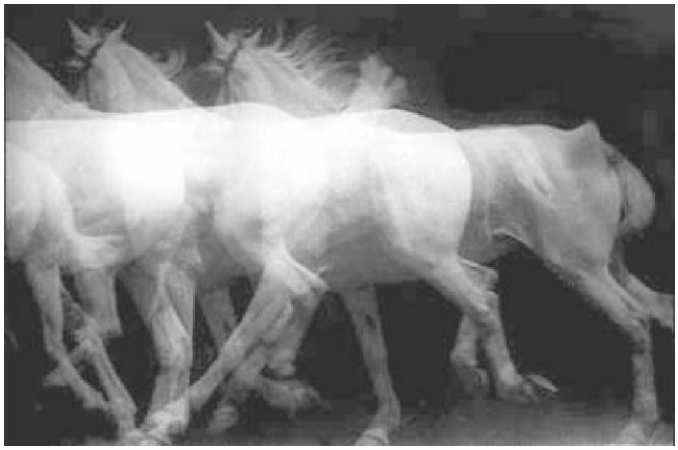

Figure 2.6: Marey's serial photograph of running horse

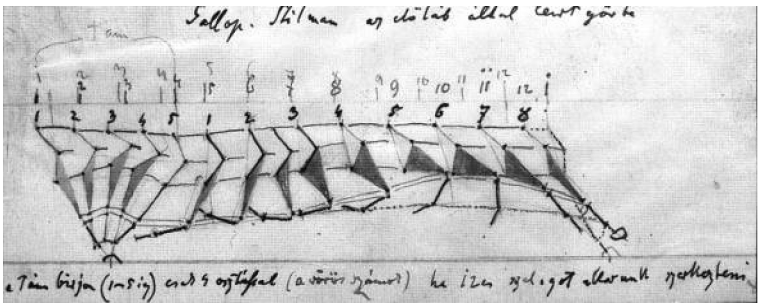

Figure 2.7: Marey's drawing of describing the running horse's movement

Étienne-Jules Marey (1830-1904)'s serial photograph helps to look close into the moment of actual movement, which is different from the sense of movement. He took photographs of a running horse in a short time lapse, and he put white dots and lines on the horse's body to make the

moving structure visible. When he superimposes the pictures together, very finely and closely, the body of the horse becomes a single body. The distinction is disappearing similar to what we actually perceive when we watch a movement of an object. There is no distinction between each moment, but a flowing movement.

What we can see in Figure 2.6 and Figure 2.7, which is his drawing of the moving structure, is that the first process is to digitalize the horse's movement as cutting by moment, which is in reality linear, and then to return the digital form into the analogue form. (Raaijmajers 2000)

When we think of it within timeline as you can see in Figure 2.7, he actually 'extended' the time between the moments of the running horse by capturing the movement moment by moment and putting each picture in a certain distance, and now it can be said that each moment now has an abstract 'extended duration' in time and space.

Bohm proposed that the basic element be 'a moment,' which, like the moment of consciousness, cannot be precisely related to the measurement of space and time. Rather 'covers' a somewhat vaguely defined region, which is 'extended' in space and has a duration in time. Marey's extended moment captures exactly profit into what Bohm was talking about. Accordingly, the relationship of each moment in the whole to all the others is implied by its 'total content'; the way in which it holds all the others enfolded within it. In this context, what Bohm thinks is that we need to think of movement in terms of the Enfolding order.

2.6.4 The process from composing to performing music

What Bohm suggests in terms of the Enfolding order, *'a moment is a movement.'* A moment contains flows or movements. The moment may be long or short, as measured in time. In consciousness a moment is around a tenth of a second. Electronic moments are much shorter, but a moment of history might be a century. (Peat 1987) According to that, the movement in Holomovement has unlimited time range. What matters is an Enfolding/Unfolding process, which means different degrees or phases of states. The process of composing music can be an example to show this aspect; the Enfolding/Unfolding process without concerning time in movement.

At the beginning of composition, a composer has a certain idea (I would put the word 'idea' since it is hard to describe what each different composer has when starting writing a piece.) for the composition. This first idea can be really concrete or abstract. The composer builds up his/her idea into a score in order to communicate with performers. Performers read the score and analyze the music including their own opinions, and play the music. At this moment, what is written on the score is being projected into a space, and is going to the listener.

There are four processes of transformation. The first process is the projection of idea from the composer's consciousness to the score, and the second is the projection of score to the performer's consciousness by reading the score, and the third from the performers consciousness to the reality, and the last from the vibrating sounds in space to the listeners' consciousness. It can be said that it is a changing 'state' of idea,

or as mentioned, an active transformation. When it comes to the Holomovement, the idea from the composer to the listener travels through each different state, which is not only abstract (in consciousness) but also concrete (in real space). However, the whole process carries the idea into the final state, which keeps its purity, (not really destroyed but can be changed), through different phases. It can be considered as a movement with exchanging the Enfolding and Unfolding order.

In this process, time is not really a matter since the process from composing music to listening to it has irregular duration depending on the methods of composing music, and parts of the process sometimes happen simultaneously(e.g. an improvisation). Nevertheless, when the initial idea is transformed into the score, the idea exists still inside the composer. The same thing happens to the performers as well. It moves, but also stays. It is in an abstract way an unbroken flowing movement.

2.6.5 Summary

The 'movement' has a different meaning from the Newtonian notion; an object successively moves from a certain place to another in a space in a certain amount of time. However in this context, it is a relationship between 'what was' in a past moment, which does not exist, and is gone now, and 'what is' now.

The essential order of movement in the Holomovement is not that of an object translating itself from one place to another, but rather, it is a *folding and unfolding*, in which the object is continually being created again, in a form generally similar to what it was, though different in

> detail. It is a relationship of certain phases of 'what is' to other phases of 'what is' that are in different stages of enfoldment. The Unfolding order of movement of the object is thus not independent, substantial, and self-existent. It is suggested instead that it is an appearance, abstracted from the Enfolding order, on which it depends and from which it derives its whole form and set of characteristic relationships. (Cobb 1977)

2.7 Enfolding/Unfolding aspects in Music

The Holomovement theory and its components including Enfolding/Unfolding order, as you have seen, involve 'actuality' through experiments in an analyzable physical dimension. At the same time, they involve things that can somewhat hardly be explained, and this is the reason for which some physicists regard this theory as one of metaphysics. However, this issue in Holomovement, in my point of view, can also be the reason to bring into the world that is concrete, and at the same time, abstract, such as *music*.

In a deeper level of music itself, it certainly has its Enfolding aspect behind 'sounding.' It is a 'projection' of composer's personal thought or life, that of mathematical representations, philosophical/political issues, and so on. It can be also said that before a piece of music is born, all those factors are 'observed' by a composer. The 'Enfolding' factor, and its result, the 'Unfolding' factors are the basic foundation of musical creation.

Electronic music (including computer music and electro-acoustic music) has been developed for more subtle treatments of sound, for using sounds from not only musical instruments, but also from 'any place' where can generate sounds with an intention to expand all the possibilities to make those sounds that can hardly be presented only by

acoustic and classical instruments and methods, and one's desire to create 'differences' that have not been produced in any other way, etc.

The Enfolding/Unfolding aspects are more clearly found in electronic music than acoustic music. Especially when it comes to electro-acoustic music and live performance for instance, there is an input sound source by acoustic instruments that comes into computer, is controlled by digital signal processing implemented, and creates another behavior related to the input sound. It is often done simultaneously, and in this case we call it a real-time processing. When we look at the process in the Holomovement point of view, sounds are enfolded as a digital signal form, treated with totally different factors such as digital signal and binary numbers, and again unfolded into a space as a new-formed sound. When it is projected into a space, thus, there are hidden factors that have functions to process the input sound source, and they can make it possible to enfold it as it is designed; the process is a path in order to enfold sounds.

When it comes to electronic music for fixed media such as one for tape, the process of manipulating sounds begins with a certain sound material (or a wave form), and then it is transformed by a variety of means of signal processing or synthesis, gathered and placed in a time line on different channels, interacted with other signal fragments together (or not), and unfolded as a whole. Enfolding factor in this case is the fact that a source becomes a different form by an artificial process, as a simpler or more complex form. When stepping back from details of the process and watching it with its causality and the result, it can be seen as an Enfolding process that becomes a different form, but similar to the previous state, creates a new form. The Unfolding elements are both what we are listening, the result, and the projection into a space.

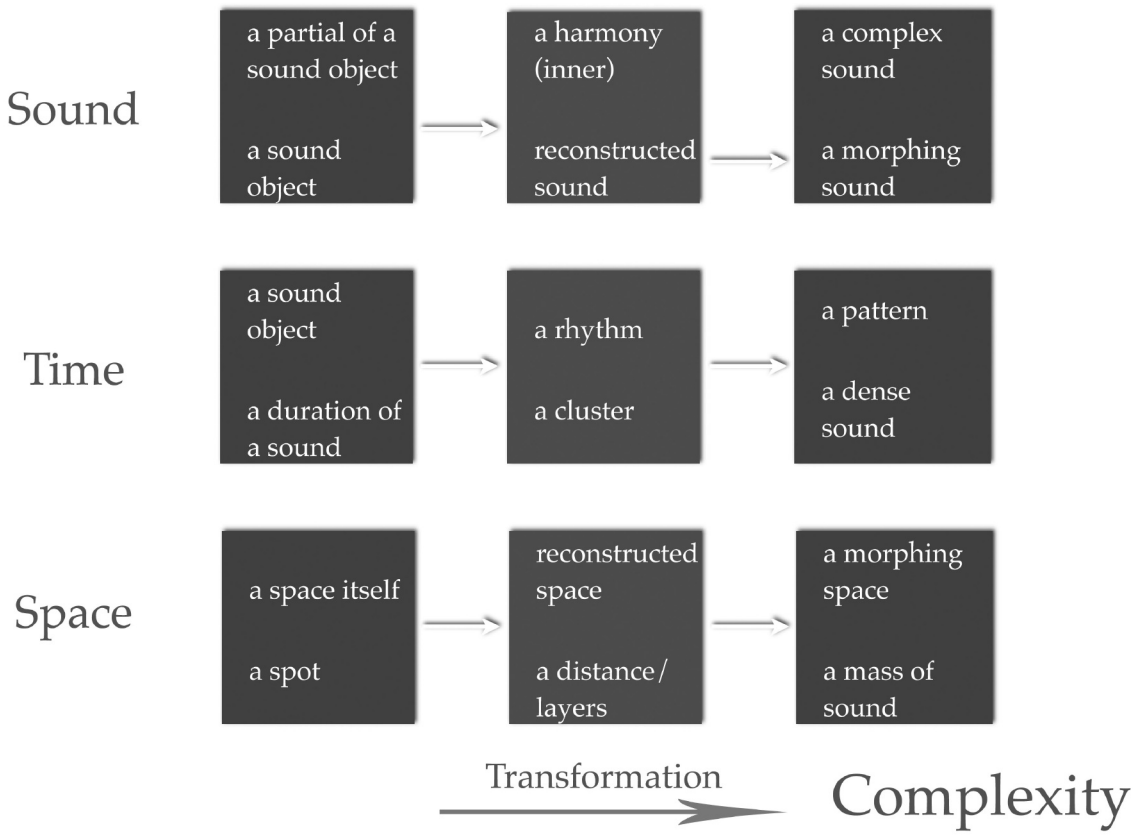

Figure 2.8: Enfolding Elements and its transformation

2.7.1 Enfolding Elements

First of all, let us consider possible elements inside a sound (Figure 2.8 the top part). There can be two division for the Enfolding order, a sound object and its inner space, *partials.* Curtis Road defines 'sound object' as a basic unit of musical structure, generalizing the traditional concept of note to include complex and mutating sound events on a time scale ranging from a fraction of a second to several seconds (Roads 2001). In this case, the Enfolding process can be to 'gather' those sound elements in space and time, and then the main issue can be the density and complexity that they are creating. For instance, when we pile up(fold) partials of a sound in many different ways, it will create different harmonies and will reach to a complex level. When we cut a sound object into a micro level of duration (e.g. few milliseconds) and reorganize them, it will create a new sound object, but there will be a similarity since the materials are the same as before. I will call it a 'morphing sound.' Accordingly, there can be a number of possibilities to enfold those elements and to make the enfoldment as a new form, which can also be enfolded into another form. Depending on the process of enfolding, we can perceive a new unfolded form of a sound, what we are listening.

Except for treating a fragment of a sound object to make an Enfolding process, there can be other factors that we can think of the way to enfold. For instance, as sound is dependent on time, we can think about the way in which the time index could work with enfolding process(Figure 2.8 the middle part). First of all, instead of dealing with a certain amount of sound fragments, we can manipulate the duration of one sound. Time can be described in terms of length, such as 'short' or 'long', or 'shorter'

or 'longer.' However, when we fold each relatively 'short' and 'long' sound unit horizontally (in time), there becomes a rhythm. When a rhythm enfolds another rhythm, it can become more complex, create a certain density as well, and can be seen as a pattern, which also can be seen as an interference pattern since a pattern involves another patterns and they will affect on each other. The more sound fragments put together *horizontally*, the more is complex pattern of rhythm made. On the other hand, when we enfold(superimpose) each sound together *vertically*, thus the start time of all sounds are the same (or not), then there becomes a sound cluster, or there is a increasing density.

When it comes to 'space' and 'localization' of sound, there can be both another factor to enfold itself and a means of making sounds enfolded. (Figure 2.8 the bottom part) The meaning of enfolding itself is that the property of a space becomes a factor to change itself by capturing it and unfolding into the space again. This topic will be treated again at next chapter with a musical example. When thinking of spatiality with Enfolding process, rather than each sound unit has an individual spatial movement in a space, they can belong to one pattern or a layered structure. Then, sound units (no matter how many units, how long the durations are) are folded into a region of a space and become different form even though their forms are not changed. The folding layer exists in a space so that it can also create a complexity made by how each unit is located in a certain zone of space. This complexity is also related to the density of sound localization.

At this point, we need to think of some issues more than Enfolding process. As Holomovement is an unbroken totality as a whole, there

should be more processing to *continue* the Enfolding and Unfolding process. In music, there are a variety of ways to make 'continuity,' and depending on which direction one is looking at, it becomes totally different issues, such as continuity of sound with duration, that of a structure, speed, timbre, placement, etc. All those factors can be applicable as long as the Enfolding process is dealing with the same Enfolding factors. An Unfolding process comes after the Enfolding process. The Enfolding process can be sensible by the Unfolding factor, but mostly the process is hidden since it happens before sounds come out. The continuous Enfolding/Unfolding process creates a movement. This means that a 'repetition' is the important factor to create the continuity. The continuity can be either to create a successive Enfolding/Unfolding process repetitively (Holomovement) or to cause another factor to enfold itself (Enfolding process).

To sum up, the Enfolding process can be applicable for compositional methods since there are several factors in music to create different enfoldments. The inner space of a sound object can be enfolded in different ways so that when it is unfolded again, there can be recreation of the sound with differences. When the time structure of a sound object is enfolded together, there can be a rhythm, a pattern or texture, or a dense sound. Spatialization is another factor that can enfold the space itself and can be the method to enfold sound objects inside. Repetition is the one to create continuous Enfolding/Unfolding process, and is the one to create folding process as well.

Chapter 3

Holomovement and its components in Music

"In my dream the earth wasn't a solid mass, but a mass of sounds held together through resonance. Everything: atoms, cells, the Earth' score, oceans, plants, animal sand humans created a complex orchestration that kept unfolding on itself. The Earth was a being of sound. The sounds were of all times; its past life was mixed with sounds yet to be heard. I heard billions of voices and all the music ever created all at once."(Michael Stearns, electronic composer)

In chapter 2, it is represented that the Holomovement theory by David Bohm gives a new way of looking at universe, different from classical point of view, with its new orders called Enfolding and Unfolding order. Those new orders in the Holomovement theory also offers possibilities to look deeply into a matter, and to analyze hidden relationship and connection between what we have thought everything is totally separated.

In this chapter, I would like to discuss about probabilities to approach and analyze music based on the concept of the Holomovement theory with a different direction from the conventional way it has been done, and several examples will be discussed.

3.1 Enfolding/Unfolding methods in Composition

In Holomovement, the most important factors that make it possible to create an unbroken flowing movement as a whole are described with the continuous Enfolding and Unfolding movement. This movements is sometimes so concrete that we can explain with physical phenomenon as we can find in the holographic principle. On the other hand, the Holomovement itself is hard to be perceived or to be explained with physical objects since it is most of time hidden behind what we actually sense. As Bohm mentioned, the Unfolding order is physical and sensible so that we can perceive it in reality, and the Enfolding order is usually what makes the Unfolding order to be perceived.

A number of composers have been dealing with an abstract world to in some way 'express' their own conclusions or ideas with sounds. The 'hidden orders' behind their ideas above the actual musical materials and parameters take a part in composition, and sometimes it is hard to be described with words since the expression with sounds can be the best way for composers to express what they intend. Nevertheless, it can be said that a hidden order certainly is enfolded in a composer's music and becomes

the background of the flow of sounds above it. In any way, it shows up itself, both implicitly and explicitly, either on or under the surface. Thus, the hidden order is unfolded on the content of music.

Enfolding factors in music composition can be regarded as one of those that take the most important part for a piece of music to be born. However, zooming out from the conceptual world in composition, which is actually composers' own point of views or philosophical ideas so that somehow are untouchable, I would like to take a deep look into their means of dealing with sound and its explicit construction in their pieces in the way how they have been treating 'Enfolding/Unfolding aspects' in sounds and in musical fragments, and will focus on what can be said in terms of Enfolding/Unfolding order in some pieces of music.

3.1.1 Joel Ryan's *Enfolded Strings*

In David Bohm's book 'Unfolding meaning,' he gives an example to explain the idea of enfoldment and its result with folding a sheet of paper. If one enfolds a paper up many times, sticks pins in it, cuts it, and unfolds it, one can make a whole pattern. So the pattern is enfolded, then it unfolds. In a sense, the holograph has a similar principle, which shows the whole enfolded in each part of the image. (Bohm 1985)

Joel Ryan, who is a performance-based electronic music composer, composed a piece of music called *Enfolded Strings* for violin and live electronics based on the 'Enfolding' aspects as a metaphor, and he talks about his basic idea of the piece with the same example as Bohms.

> *"When squares of paper are turned into three-dimensional Origami,* ***complexity*** *is created by folding simple forms into higher dimen-*

> *sions. So in music, polyphony can be seen as simple material folded in time to generate richer, more compelling forms. Conversely, complexity is made simple by a change of perspective. What seems difficult to grasp in a projection into one or two dimensions is comprehensible when viewed in three dimensions. A flatlander perspective forces the "folding up" of phenomena, squeezing them into a more limited dimensionality. However a change of perspective is revealing, whether the higher dimensions are "natural" to the phenomena or are completely fictitious! This suggests that* ***folding/unfolding*** *is a method for creating and decomposing complexity. Cognition of music can be said to consist in the invention by the listener of models or transforms which unfold the complex information contained in the sound."(Ryan 1994)*

His approach to Enfolding/Unfolding aspects came from regarding the richness of sound by an instrument. He considered that during the synthetic process of an acoustic instrument in computer music or electronic music, the 'richness' of the instrument is often lost and it can be seen as the difficulty of devising synthetic processes of a complexity. To overcome this problem in this piece, he combined the original sound sources from violin with the formal facility of computer music. He says that the computer is jacked into the rich physical flux to provide a rich temporal ore from which new sounds as rich as their sources are extracted. (Ryan 1994)

The meaning of 'folding' in this context could be the folding of sound of original sound of the violin and pile it together with processing sound from computer, which actually is made by violin as well. Then, in his

point of view, they are unfolded into a space and to audience and by audience. He mentions that

> *"Cognition of music can be said to consist in the invention by the listener of models or transforms which unfold the complex information contained in the sound. The composer constructs music by enfolding structure, the listener tries to unfold it, to recognize it, perhaps rediscovering the methods of the composer or perhaps just finding any model which allows him to enjoy the music. What is interesting here is the duel of folding and unfolding and the fact that more than one model can work."(Joel 1994)*

He basically used the Enfolding/Unfolding aspects both as a method to create a rich sound from a traditional instrument, and as a metaphor that can be physiologically explained by the cognition of audience, which is the listening process with Enfolding/Unfolding movement.

3.1.2 Enfolding/Unfolding aspects in Xenakis' *Pithoprakta*

To create an Enfolding/Unfolding movement in music, there should be a basic element to be an Enfolding object that I described in the last part of chapter 2. For example, when a partial of sound is chosen, and in the most simple way it is piled up with other partials(an Enfolding order), a complex sound can be made (an Unfolding order). Remind us that one of the main reasons to enfold a certain element is to create 'complexity' with unified characteristics since the Enfolding process deals with a single object of a parameter of a sound in time and space. The complexity, of course, is different from which element one chooses

to manipulate with any kind of purpose. We can take a look at the methods with Xenakis music since he can be one of the most representative composers, who used a variety of folding structures in different directions and dimensions. A number of his pieces involve clouds of sound and dense and noisy textures not only in his electro-acoustic music, but also in his orchestra music, and many of them can be regarded as including different means of Enfolding means. I chose *Pithoprakta* as an example, and we will look at the elements as Enfolding process especially with graphical representations. This can not only help to clarify and understand the meaning of the folding and unfolding process in music, but also, I believe, be helpful to extend the range of possible ways to create an Enfolding/Unfolding movement.

I would like firstly to talk about his linearity that represents his musical gesture. The musical structures he imagines -his glissandi, mass sound and arborescences- give a sonic appearance to archetypical morphologies such as straight or curved lines, incurved surfaces, clouds or tree-like shapes. (Iliescu 2005) The correspondence between music and architecture, as he conceives it, actually is founded on the universality of line. Composing music, he remarks, amounts to lay a series of points on a line. (Beaudot 1973) He expressed linear motions often with drawing on a sheet of paper that can perceive easily its continuous movement in pitch-time space. In *Pithoprakta*, glissando movements of strings instruments mainly express the linearity. Xenakis implemented the law of Large numbers and Boltzman's Kinetic Gas Theory as a method to aggregate sound events and to create the cloud of pizzicato glissando respectively. Xenakis is probing towards the law of large numbers: that the more numerous the phenomena involved, the more they will tend

towards a determined goal. (Kay 1967) The glissando and its composition show this fact.

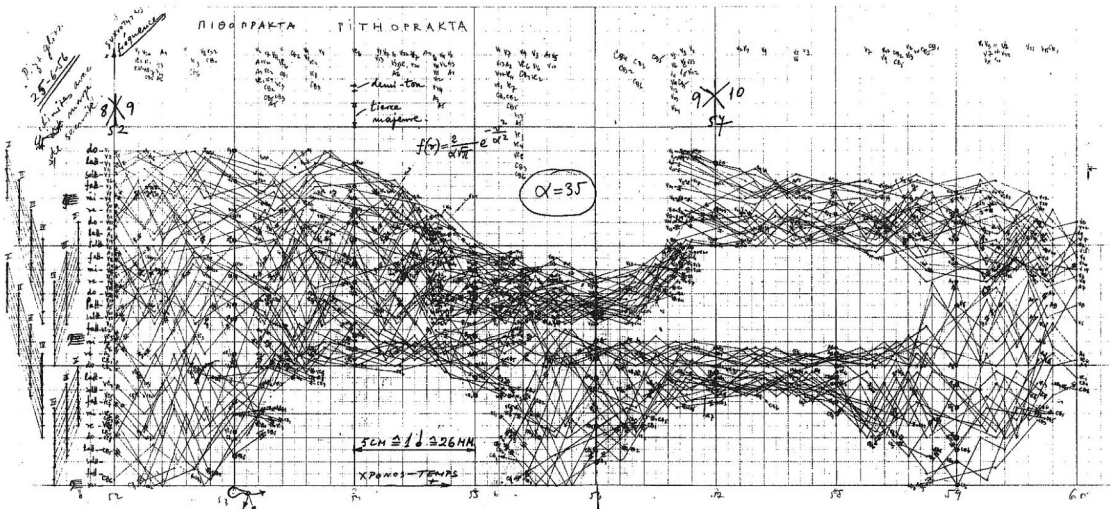

Figure 3.1: extitPithoprakta measure 52-59: graphic by Xenakis

In figure 3.1, the individual glissando movements of string instruments are grouped, and they shape sinusoidal movements so that in a large scale of glissando, movement is constructed with individual, independent glissandi called *Glissandi of glissandi.* Then at the end of this section, all glissando movements are united into a single large glissando and then are unfolded into a sustained chord. At this point, the process of creating of a glissando could be seen as a folding method, so that the whole movement is literally unfolded(sustained). Trever Wishart is describing about this gestural unfolding of events in *On Sonic Art* that there is as yet not a moment-to-moment feeling for the gestural development of musical form, which can be seen as a feeling of flow. All forty-six strings have individual figures, now unbroken except by the re-attack necessary for their pizzicatos, so that, at any given moment,

there can be no exactly defined aggregate of sound. Individual sounds disappear in favor of a symbolic representation of 'energy quanta', to borrow another image from physics: a set of parts revolving and transforming themselves around varying areas at varying velocities. (Harley 2002)

It can literally be seen as an unbroken flowing movement as a whole by Enfolding/Unfolding movement. Let us remind the hierarchical Enfolding order above the Unfolding order mentioned in Chapter 2(Figure 2.4). When a physical event happens, under the event there are successive Enfolding orders that cause the event to reveal. They have a direct relationship in their characteristics, so that by analyzing it, one can find out the connection between the event and its Enfolding order. In *Pithoprakta*, there is an implication (a folding of sorts) of musical gesture and construction, which Solomos describes in *Iannis Xenakis* as the music's closed selfhood (its Gestalt) being folded into the musical artifact. The dualism of gesture and sonority, illustrated by the most emblematic example, is the glissando. (Iliescu, 2005) The Enfolding in glissandi of glissandi accordingly is that each string instrument has its individual gesture (micro scale), and they are folded together, and create a macro scale form. Furthermore, this macro form of the glissando is similar (related) to the microform of the glissando due to the fact that it enfolds behaviors of the micro forms so that it can be seen as an Unfolding result as a whole.

3.1.3 Luc Döbereiner's *Piz Palü*

In the above Xenakis example, the Enfolding/Unfolding aspects can be found in relationship between the micro and macro level. *Piz Palü* by Luc Döbereiner shows somewhat similar concept to *Pithoprakta*, but his case is more implicit and hidden since it is directly involved in the method of generating sounds, their structures, and the whole musical form. To understand the relationship between this piece and its holo-movemental characteristics, it is necessary to take a look into the way of composing sounds and structures.

Piz Palü was composed in 2007 for 4-channel fixed media. This piece is constructed with streams of events, which unfold in a dendritic structure. The sound synthesis method is basically similar to Iannis Xenakis' dynamic stochastic synthesis.

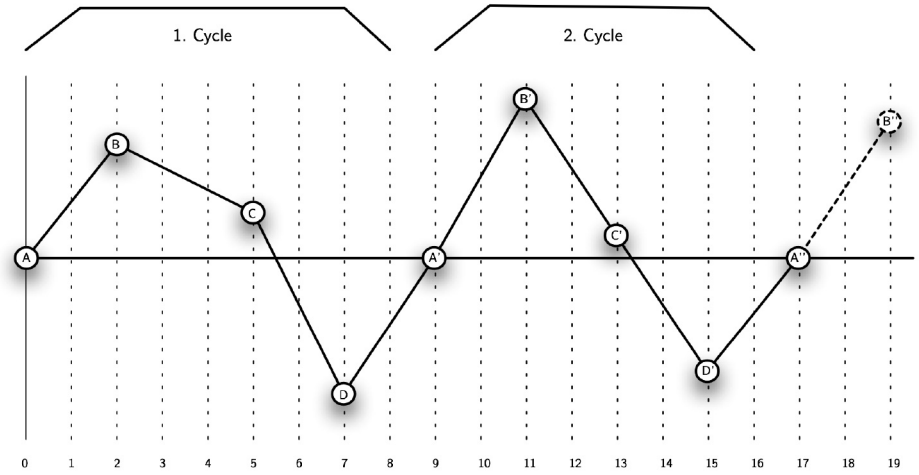

Figure 3.2: Stochastic Synthesis as commonly implemented(Döbereiner 2008)

Figure 3.1 shows breakpoints of two cycles including 4 points(A, B, C, D) linearly interpolated and following its own path. It means that in next cycles this vertical and horizontal position of each breakpoint represented by the letters are deviations of their previous states. (e.g. A-A′-A″, B-B′-B″, etc)

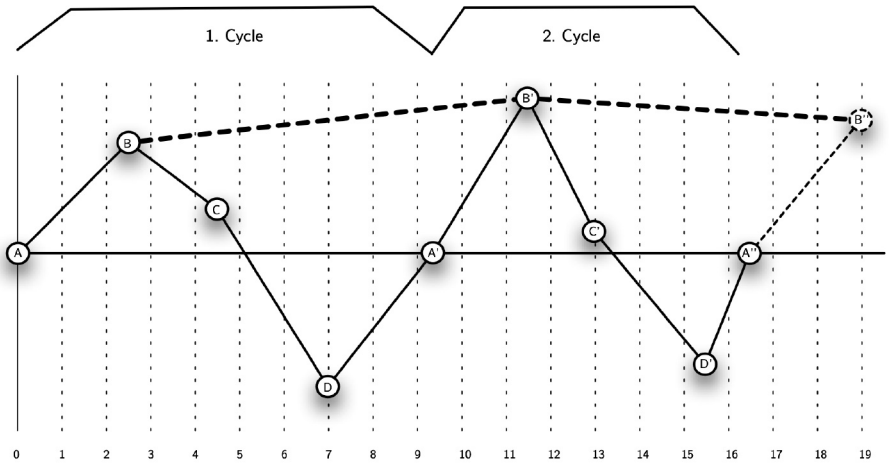

Figure 3.3: Highlighting the course of B's amplitude development(Döbereiner 2008)

There can be two different breakpoint positioning procedures: one is to position breakpoints in the sample grid (Figure 3.2), and the other is to position them in a continuous space independent of the sample grid (Figure 3.3). In the first case, which is basically how dynamic stochastic synthesis is usually implemented, the original cycle duration will be changed by the position and duration changes of the breakpoints. It means that in figure 3.2, the first cycle includes 9 samples, and the second has 8 samples(Figure 3.3), which creates different durations of cycles, in other words, different frequencies. In the second case, which is used in *Piz Palü*, according to the positioning of breakpoints in between

samples, it is thus possible to create cycles whose lengths, thus frequencies, correspond to any value (within the usual constraints of digital oscillators), independent of the sample rate, and can change continuously. (Döbereiner 2008)

When it comes to the structure of the entire piece, there are 8 points in time that are targets to be reached. Those targets are to create the event streams. The composer calls those points *"target constellations."* The role of target constellations is to decide the number of event stream, density, and frequency at a certain fixed point in time so that it differently determines the density, timbre, and duration of a section. There is another type of points called *"decision points"* that include four different decisions for an event to be progressed; continue, split, merge, and die. (Figure3.4) Then according to those points, which are spread all over the piece, a stream of structure is created. (Figure3.5) While the 8 points determine long-term, formal changes, the decision points determine local, short-term changes.

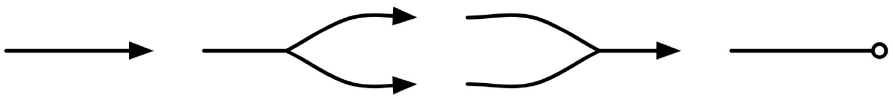

Figure 3.4: continue, split, merge, and die(Döbereiner 2008)

The interesting fact that we can think of this piece with the relationship to the Holomovement can be described firstly with the procedure to create samples. There is an original sample, and according to the first breakpoints and their behavior, it keeps being mutated (transformed).

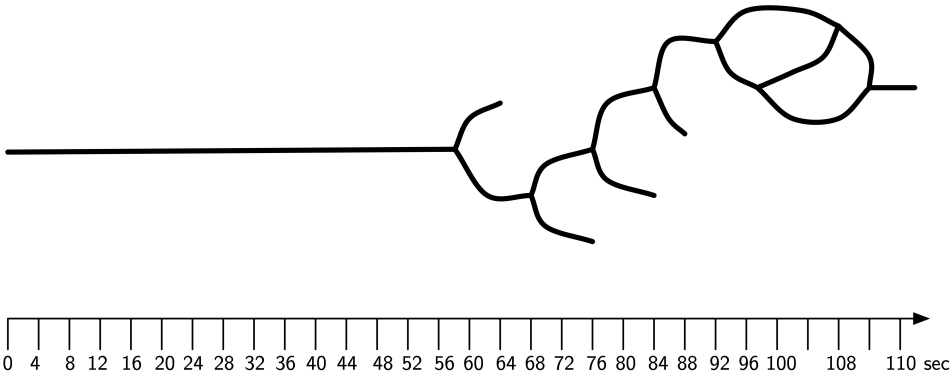

Figure 3.5: The event stream structure of the first 110 seconds(Döbereiner 2008)

In the hologram model, when one projects light to any part of the hologram plate, we could create the original object, and with this experiment, we could find out that the hologram plate includes the object all over the space.

Imagine that we cut a part of *Piz Palü* and analyze it, and then we will find all similar structures of each wave constructed by the behaviors of breakpoints, which recreates itself continuously according to the previous states. The composer states that :

> *"Piz Palü can be seen as a number of multiply self-referential processes enfolded on different time levels, creating variants of a single event which unfold in the course of the piece."(Döbereiner 2008)*

In this context, I would say that the breakpoints, which make it possible for each wave to control itself and determine its duration, timbre colors, and frequency, is the Holomovement that carries Enfolding order to be unfolded. The Enfolding order here can be each behavior of each

breakpoint, which has a direct connection to the result of reconstruction of a sample. In this way he recreates an aspect of the original samples (not digital sample points but audio sample fragments). He also states this aspect that:

> *"There are 4 distinct spectra of musical sounds used as basic materials. However rather than using them to recreate a recognizable effigy of the original, they serve as points of departure, arrival and reference. During the course of the piece these spectral materials are juxtaposed and transformed. "(Döbereiner 2008)*

This may be seen as a form of projection, an aspect of the basic material is composed with, made audible, without ever recreating a recognizable effigy of the original.

He also states about the relationship between macro and micro structure similar to Xenakis' 'Pithoprakta' that the whole structure (macro level) embraces smaller structures (micro level), which are analogous to the whole structure.

> *"At the core of the concept of stochastic synthesis lies the idea of unifying the macrostructure and the microstructure in composition and use procedures which have been successfully employed on a higher level for the synthesis of sound. Piz Palü can be seen as an attempt to reverse this application and use signals produced by a stochastic synthesis algorithmoriginally intended to be audio signals -as parametric control signals."(Döbereiner 2008)*

Furthermore, when we see in this piece the way of creating the whole section in time, we can find the whole structure of the entire piece is created by 8 fixed points, and each section has many decision points including its four different behaviors of how to be unfolded in time. In other words, it has the characteristics of a repetitive pattern that is different but similar to each other. It creates a movement in Holomovement that is built by successive different states. Each section can be seen as a different state by a different enfolding elements created by a different organization of decision points. Each state is not so much different from previous one, and continuously progress its behavior.

3.2 Repetition/Transformation as a movement

In chapter 2, it is discussed that the 'movement' in the Holomovement is different from the classical point of view that an object moves from a place to the other. The movement here is made by a different state from the previous state by repeating Enfolding/Unfolding order since the repetition is not just to restate itself, but to create 'differences' in between, which are made by 'transformation.'

The meaning of transformation in music can be defined as any operation or process that a composer or performer may apply to a musical variable. It takes a part to create a movement together with repetition. The movement in this context is of the musical perception and its tendency that shows moving from a state to another state by manipulating all possible parameters, such as time durations, rhythmic patterns, timbre structures, etc.

In electronic music, the term transformation is generally used for those cases that a sound source is manipulated by another input/control signal, a different kind of

synthesis/resynthesis, and a simple/complex change of different parameters of both the original source and control source. It means that when one changes a sound and creates somewhat different results with such procedures, a 'transformation of sound' happens. Of course in electronic music, there also can be a musical transformation that with structural changes and modulation, the whole mood or progress is transformed into another form. However, we are going to focus more on the transformation of sound.

For regarding transformation as a factor that creates a movement, the range of transformation could be in a way limited because the source of the transformation should not be completely changed into another form at once. It should happen with continuous, progressive changes or certain patterns that are *'repetitive'* so that one can perceive the difference between the former and the latter, which actually means perception as a movement. **'Repetition' accordingly gives a breath to the transformation to 'move.'** Thus transformation can be considered as the Enfolding order as well depending on its method since it is the background level of the main action that a source can be changed, and each result, which is unfolded by the transformation and is taken an action by repetition, creates a 'movement'. To be clear, it is better to take a look into some musical examples.

3.2.1 Pierre Boulez's 'Transformations' and 'Horizontal Arpeggio' in *Répons*

Pierre Boulez (1925) talks about transformation with his *Répons* (1978-1985) in the interview with Josef Häusler (Häusler 1985) that the sounds of the soloists are neither amplified nor distorted; they are 'transformed.' There is threefold sense of the sound events; the natural sounds of the instruments, the distorted sounds of the instruments, and the synthetic

electronic sound, and this threefold perception of sound was crucial to him. He used two different transformations of instrument sounds: the tone-quality transformation with the ring modulator and the frequency modulator, and the structural transformation-the structural extension. He talks about the structural transformation as follows:

> *"Concerning structural aspects, one can go further with computer technology than with analog technology. For example, I can give a rhythmic profile to a sound through delay. This profile can remain the same, and in addition it can be modified. Now when I gather two, three, four or six such sounds, I also get two, three, four or six different sequences, and I can still modify these sequences in each instance. In Répons, there is a passage in which what the soloists play if delayed according to a certain rhythmic sequence; however, when this passage returns, it is transformed through a new time sequence with a changed timing. I could also couple this whole process with a Klangfarben, a timbral, transformation." (Häusler 1985)*

We can compare this process with Bohm's folding paper. As we fold a paper several times and it creates a pattern, sounds fragments with his rhythmic profile are folded (or gathered) together with other sequences, and it creates a new pattern, which can be modified at the same time, in his term, 'a rhythmic profile.'

About the process of this delayed sequence called *'horizontal arpeggio.'* Pierre Boulez's aim was to take a moment of sounding by an instrument in real-time. The moment in this context is vertical because of the inner structure of sound nature. Then it is overturned into so-called *'horizontal*

arpeggios.' Normally arpeggio is perceived vertically since it is 'pitch related' movement toward up or down in succession. However, in *Répons* it is not a pitch distribution, but a sequential sound repetition aided by real-time computer processing. The repetitive sound comes out from the 'mother-sound' (Raaijmakers 2005) that is caught from an instrumental figuration by microphone and real-time computer processing. When the mother-sound occurs, sounds created by computer continue, repeat themselves temporally, and make a 'tail' of the mother-sound. It is harp-like sound sequences according to the figure of the mother-sound so that it has both vertical (by its pitch distribution) and horizontal (by repetition) movement. A movement by the horizontal arpeggio comes along with another, creates complex patterns and fulfills the space with its spatiality.

Dick Raaijmakers in *Cahier-M* also talks about this process that structuring these sequentially arrayed surfaces leads to a better comprehension of timbre than the way in which this particular quality of sound is normally understood. In his point of view, this process also expands its clarity. Timbre in this context works as more than the characteristics of a sound; it has an active potential, which a given sound-aggregate, to unfold itself in space under suitable conditions, literally enclosing and filling up that space, and of course, not just in an obscure kind of 'ambisonic surround'-like form but also compositionally in the best sense of the word. (Raaijmakers 2005)

He in a way explains very well the Enfolding/Unfolding process in horizontal arpeggio. The Enfolding aspect can be the captured moment which is the mother-sound. It becomes a new form and creates a layer

with other musical events. It keeps its own quality but becomes the 'sound-aggregate' that unfolds itself in a space with surrounding the space. Then, each sound fragment can be considered as an array (with changing states) of the Unfolding order, and the moment by capturing sound can be the Enfolding process. Its spatialization is beyond the function of filling up the space as an articulation, but 'its very spatiality is being composed.'(Raaijmakers 2005) This is one of the points that it becomes a dynamic Enfolding/Unfolding movement because it is different from the one that sound aggregate just comes into a space as it is. It is controlled, and its movement is planned. This movement gives a rise to the fact that the repetitive unfolded fragments becomes active and alive. According to its different localization in both time and space, each fragment has each different factor that makes each of them different but just similar. It would be considered 'static' according to the figure of each sound fragments, but at the same time is a 'movement' by carrying itself behind other musical events. An active event is transformed (enfolded) to a fixed frame, and by repetition with spreading (Unfolding) into a space; it becomes a movement, rhythm and atmosphere.

3.2.2 Xenakis ' Sound transformation in *La légend d'Eer*

Xenakis worked in particular to create shifts and continuities of density through layered variations of sound objects. (Delande, 1997) *La légend d'Eer* (1977-1978) can be one of the representative examples of the Holomovement since it is created by an unbroken flowing movement with comparatively long duration in time by constantly transforming sound materials and their linked layers. *La légend d'Eer* is a 7-channel electro-acoustic composition, and the sound materials mainly stem from

three sources: instrumental sounds, noises, and electronically generated sounds. The outline of the piece is developed in the order of an initial departure, a journey, and a final return, and its structure is more precisely divided in 8 sections. (Figure 3.6) I will choose some particular sections and talk about the characteristics that can be compared with the Enfolding/Unfolding aspects.

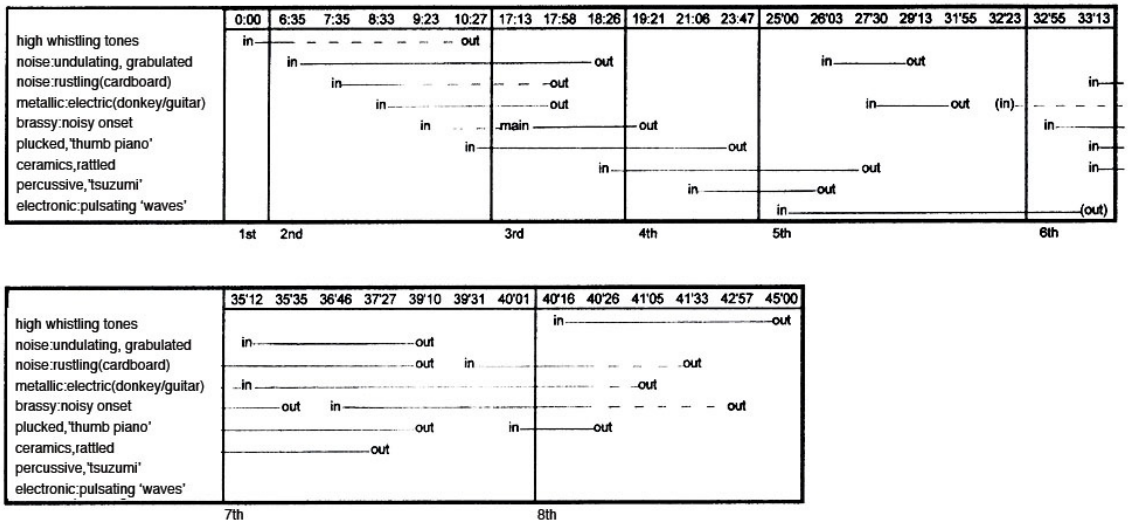

Figure 3.6: The structure of *'La légend d'Eer'* (Harley 2000)

The piece starts with the high whistling sound, which is called "sonic shooting star" by Xenakis. Let us look firstly into the processing of whistling sound. This sound becomes smoothly a layered structure with different pitches, and it is varying in time to tremolo generated by the amplitude modulation. The whole change consists of sequences moving from the plain sound to the tremolo for around 10 minutes. Each sequence is not connected, which means each sound starts and ends, but is not bonded as a sustain note. It is an array of sequences. This simple procedure can be seen as a very comprehensible example of the

Holomovement since it includes the Enfolding/Unfolding movement as a whole. The hidden (Enfolding) order is the changing parameter used for the amplitude modulation, and it creates each different state of the gradually changing sound, the Unfolding results. The repetitive sequences bind them as one movement so they flow.

A similar pattern can be found at the pulsing 'waves' through the fifth section to sixth section(Figure 3.6). Taking a step from the previous events, the fourth section starts comparably calmly with particle-like sound layers; plucked African thumb piano sounds, ceramics rattles sounds, and percussive tsuzumi sounds. When those sounds are joined with the pulsing sounds, the development of percussive sounds alter into that of electronic sounds. This alternation happens with sequences of sound with slight changes of processing following to the pulsing sounds, and the pulsing sounds have its own path as well. The change of an event is similar to the first section, but more complex and in the higher level since it includes layers of events and at a moment the layers seem interacting each other since the pulse sounds are revealed to the front. In other words, the pulsing sounds are leading all other events to create a pulse-like motion, and they musically develop together from a certain moment to a certain level that creates all the tension and excitement. It continues for the sixth and with brassy noisy sounds. The reason that can be seen as an Enfolding/Unfolding process is similar to the first section as well. It repeats itself but with a slightly different level. The pulsation is the one that actually is individual. However, because of the relationship between the pulses, it can be seen as a movement. Let us remember the sense of flowing movement that I have talked about in the chapter two. In the Holomovement, the physical connection (to

flow) between two events is not really a matter to decide the movement to flow, but the relationship between the events creating a sense of flow is the important fact to decide an event to be a movement. When we listen to the pulsing sounds, we do not perceive it as an aggregation of sounds event, but a flowing movement. There certainly is an audible time gap between pulses, but it is flowing due to the whole structure of the pulsing sound. That could probably why the pulsing sound is called the pulsing 'waves.' It is interesting to see that he created a wave with the pulses.

A layer of a sound material individually starts and ends with a variety of methods including transposition, filtering, and reverberation, and they do not share the means together. Each movement is clearly separated. However the transformation of each event creates the links between the entities since the transformation causes resemblance between the sound events. Thus, while the entities are relatively distinct, they can also be related along the different parametrical continuity. Each layer is repetitive and developing its own transformation in time, and together with others it creates a sound mass. I strongly believe that the main thing that creates ceaseless fascination while listening even though the duration of the piece is relatively long is this flowing movement of events that keep their own steps with interacting 'indirectly' each other, and create the whole journey. The'indirection' can be said because there is no direct, physical unity of the events, but each event and its movement create a 'harmony.' (I derived this method with the inspiration to create a flowing movement to my works, *Hu-tn Gut* and *Jac-du ta-gi*, which will be discussed in the next chapter.) This can be said that each layer keeps Enfolding and Unfolding in time, creates different states to-

gether with other layers, and moves to a certain level as a whole. The important factor here is the repetition in a layer, which creates different states, and the layered structures, which create density so that in a certain point, it is not individual anymore, but becomes one whole movement.

3.3 Feedback system and the Holomovement

3.3.1 Alvin Lucier's *I am sitting in a room.*

In chapter 2, it is shown how the Enfolding order can be described visually by the hologram model. As explained, Holomovement is an unbroken flowing movement by a successive change of Enfolding/Unfolding order. By the projection of light through the hologram plate, the original object is reconstructed to another form. Thus, light becomes a *medium* that makes it possible to describe the exchange of Enfolding and Unfolding order. Alvin Lucier's *I am sitting in a room* is one of those that can be regarded as an example using sound and space as a medium of the Holomovement.

Alvin Lucier's text makes a way for the journey of sound immanent in a room. It begins with reading the text in a room. Once the speech is recorded with a microphone, it returns into the same space by playing with loudspeakers, and at the same time it is being re-recorded by the microphone again so that a set of feedback loop is created. Repeating this process through various numbers of generations, parts of the sound

become enhanced and reduced by specific resonant frequencies in the room. Thus, the speech is gradually transformed into music. His text itself includes the whole procedure as well;

> *"I am sitting in a room different from the one you are in now. I am recording the sound of my speaking voice and I am going to play it back into the room again and again until the resonant frequencies of the room reinforce themselves so that any semblance of my speech with perhaps the exception of rhythm, is destroyed. What you will hear, then, are the natural resonant frequencies of the room articulated by speech. I regard this activity not so much as a demonstration of a physical fact, but more as a way to smooth out any irregularities my speech might have."*

We can compare this process with the hologram model. The interference pattern on the photographic plate is made by both the reflection of the object by laser beam and direct laser beam. Since any part on the plate includes all information of the original object, it is considered as an Enfolding order. The possibility of the sound journey in a room, in other words, the properties making speech variable, can be regarded as the Enfolding order. This is due to the fact that each part of the room makes reflection of the whole sound even though each different region has different properties, and the reflected sound is caught by the microphone, which can be located in any part of the room. The recording system including the microphone, which is comparable to the photograph plate in the hologram model, enfolds the speech and its reflection. The 'playing' system including the loudspeakers, which is comparable to the laser beam into the hologram plate, unfolds the recorded sound into the space again, which can be regarded as an Unfolding order. The micro-

phone enfolds this unfolded sound again with recording and playing simultaneously. What we are listening through each phase by speakers shows the Enfolding order, which is not only continuously changing its status by repeating the process, but also keeps its purity. All phases in this piece can be considered as a transformation as a whole, in the Holomovement point of view, a 'flowing movement' from a speech to music.

What makes the transformation from speech to music is the point of the possibility to see this piece as an example of the Holomovement aspect, which is not only the phenomenon of sound reflection and its reactions, but also 'feedback loop system.' 'Feedback' is a system where a transformation occurs, and there are inputs and outputs. The inputs are the result of the environment's influence on the system, and the outputs are the influence of the system on the environment. Input and output are separated by time duration, as in before and after, or past and present. (Rosnay 1979)

In the Holomovement, however, this time duration is not a matter to be explained since the movement part does not include a time duration, but focuses on the changes of state. Thus, what should be pointed in the feedback system is the way to make a reconstruction of an object as an Unfolding order, within a system as an Enfolding method.

3.3.2 'Audible Eco-Systemic Interface' by Di Scipio

Agostino Di Scipio, who has been focusing on the 'man-machine-environment' feedback loop, derives one of the representative feedback

systems. He introduced 'Audible Eco-Systemic Interface (AESI)' that aimed to function only based on purely acoustical information including, in particular, the ambience noise. The ambience is the real - not virtual - space hosting the performance. (Di Scipio 2003)

More than two microphones are scattered in a room. Some initial sounds are sent out from computer and heard through loudspeakers. Those sounds are caught by microphones and the computer analyzes the signals and extracts information on relevant sonic features, which generate control signals and drive the audio signal processing parameters in DSP patches. Then, the computer-generated sound is emitted as well. Also the previous signals coming from the microphone are matched against the initial sounds, and the difference between two signals is calculated and is used to adapt a number of signal processing parameters to the room characteristics. (Figure 3.7)

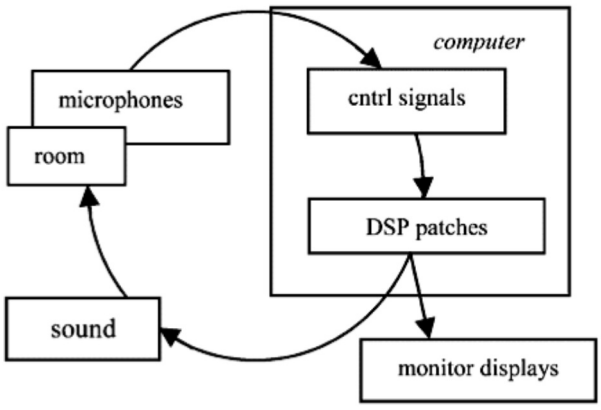

Figure 3.7: Basic design of the Audible Eco-Systemic Interface

The result of this system is a flux of constant changing initial sounds according to the room resonance similar to Alvin Lucier's piece. In this system, DSP patches affect the total sound in the room by generating a new sonic material. However, the principle can be compared with the Holomovement since the system enfolds initial sounds in the way implemented by DSP patches in computer, and then unfolds the processed sound into the space again, and makes continuous loops. It creates a flowing movement, which can be considered an unbroken totality as a whole. The movement here is again not a movement of sounds in a space through loudspeakers to be caught by microphones due to the reflections of sounds, but the one of the different states made by traveling through the system repetitively.

3.3.3 Roberto Garretón's 'Autonomous System'

In 2006 at the Institute of Sonology Roberto Garretón built a feed back system called 'Autonomous Computer Music System' and created a piece with the system titled by *Chopped Dialogue.* The system has much the same principle as AESI.

He used Contrabass to make the initial sounds through a closely standing microphone. Different from AESI, it has a continuous musical structure to trigger the system constantly, and at the same time to make a musical structure. He put another omni-directional microphone in the middle of the room to catch the sound journey coming from loudspeakers interacting with the air according to the room properties. The system has dual features to control the feedback effects; one to stimulate the activity, and the other to cancel the activity.(Garretón 2007) He calls this

process the '*compensation*' process, in the place system oscillates from rest to unrest, from quiet to loud, from sparse to dense. It is similar to generating the different-signal with the values from DSP patches in AESI, and it makes a certain stability.

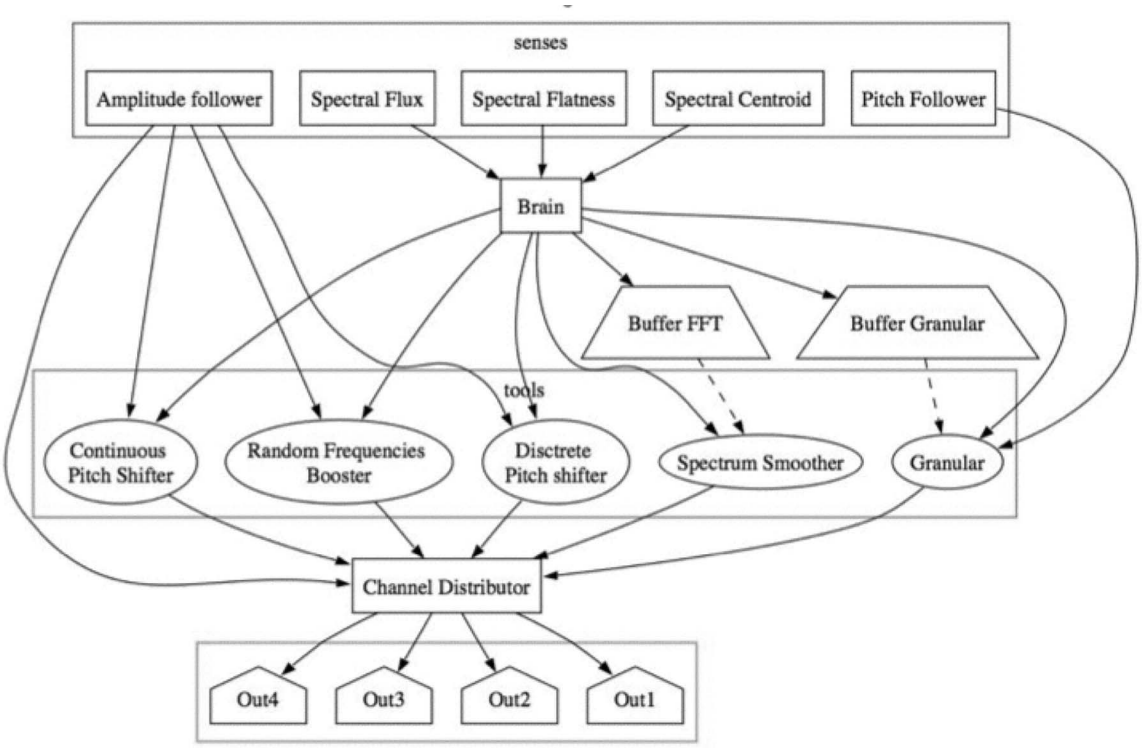

Figure 3.8: Autonomous System by Roberto Garretón

The output from the system generates musical activities due to the format of transformations. (Figure 3.8) According to each module of the system, each parameter passing through the system creates its own 'behavior' without another kind of control input from outside. The system acts as an environment that gives sounds a space to travel inside the system and at the same time inside the room.

The result, what we can clearly hear, is not merely the changes of initial sounds through the microphones and loudspeakers, but each phase made by passing through each module in a short moment. In other words, a sound source is evolving and developing successively, and it makes a 'phrase' due to the function of the modules, and the phrase goes into the microphone again, and it makes another phrase until it becomes stabilized by the compensation process. It creates not only the fragments of phrases but also musical structures. Each source is enfolded into the system and unfolded to the space again, and create each different state, which can also be considered as a movement by transformations. It can be continued until the 'environment' disappears, all are compensated, or there is no more input source. It activates itself, creates dynamics, continues Enfolding and Unfolding by itself, and generates continuous changes according to the environment. As the hologram model has its way that an object is generated by the laser beam and the beam splitter, this autonomous system is there to create a pattern and to reconstruct the initial sounds as a new musical phrase.

3.4 Summary

As the above examples showed the aspects that can be seen as Holomovement and the Enfolding/Unfolding orders in music, we can summarize how to apply them to music.

The first can be to select the basic element to create an Enfolding/Unfolding movement. The selected element will be the object that one can deal with the Enfolding/Unfolding methods. It can be a frame of a sound

(e.g.Luc Döbereiner's *Piz Palü*), a phrase of sounds(e.g. Xenakis's *Pithoprakta*, Alvin Lucier's *I am sitting in a room*), partial structures(e.g. Joel Ryan's *Enfolded Strings*), and localization of sound in a space(e.g.Pierre Boulez's *Répons*), a space itself (Di Scipio's AESI), etc.

Once an element is chosen, there can be an Enfolding method that can lead the selected element to be developed (to move). The Enfolding order in this context can be described with 'transformation.'(e.g. Luc Döbereiner's stochastic procedure, Alvin Lucier, Di Scipio, and Roberto Garretón's feedback processing, Iannis Xenakis's glissandi, etc) The method of transformation is the Enfolding order that is hidden in reality so that you cannot perceive, but it causes the Unfolding order to exist. The Unfolding order is what we are listening, the result by transforming sound. This is proper to electronic music since the procedure for transformation in electronic music is mostly not obvious and hidden. As the Enfolding order cannot be directly observed without an analysis, the method for transformation in electronic music can be seen as an Enfolding order.

As Holomovement is an unbroken flowing movement as a whole, the Enfolding/Unfolding movement is continuous. (e.g. Pierre Boulez's 'horizontal arpeggio,' Alvin Lucier's 'feedback looping,' Iannis Xenakis' 'the flowing transformation' in *La légend d'Eer*, etc) This repetitive movement in this context is not one that is repeating itself constantly, but by the method of transformation it is changing and morphing its state step by step. Accordingly, the element will be changed and developed into another form.

Thus, Holomovement can be found both in a part inside a piece of music by observing its organization and in the entire piece. The important thing that we can consider between musical creation and the Holomovement is the opportunity that we can observe carefully how a simple element can develop in a specific way until it reaches to a complex level with carrying itself and creating a musical tension and mood. The terms, Holomovement and Enfolding/Unfolding orders are the metaphors that reflect the behaviors and methods of musical events. This processing of viewing in a different point can help to widen the ideas for composing music and to deal with looking for the methods to organizing and manipulating musical parameters.

Chapter 4

Nea-Rim Gut and the Applications of the Holomovement

In this chapter, we will take a look through my own music compositions, and theirs conceptual backgrounds and structures to find how the Holomovement theory and its components can be applicable. The theory gave influences not only in technical applications, but also in the compositional ideas and methods in deeper, abstract level. From 2006 to 2008, a series of electronic music pieces titled by *Nea-Rim Gut* composed with the Holomovement-based ideas. There will be following a short introduction of the pieces of the series, and the relationship between the musical ideas and the Holomovement theory.

4.1 *Nea-Rim Gut*, a series of Electronic music pieces (2006-2008)

4.1.1 Introduction

Nea-Rim Gut is a part of the Korean ritual called *Hwang-He-Do Gut.* Each region in Korea has different types of ritual music according to its characteristics. Since 'Hwang-He-Do'is a province in North Korea and is close to China and the west sea, the character of this region is both continental and protective. The ritual of this area thus includes very strong musical and rhythmical color and varying functions. *Nea-Rim Gut* is the sixth sequence of the bigger series of *Hwang-He-Do Gut. Nea-Rim* means 'to inherit' or 'to come down', and *Gut* means 'a ritual.' This ritual performs the process that a person becomes a shaman. It includes eight sequences in total, but in this series four important processes were chosen to be reformed.

This series of electronic music includes five pieces, and one of the pieces symbolizes the whole process;

1. *Between*: the whole process of becoming a shaman, the changes of shaman's consciousness, and the group consciousness in the ritual are symbolized by the musical structure, materials, and musical process.

   and the four important processes:

2. *Open Your Words* for Recorder, Jing and Live Electronics : the process that the person goes to a mountain, and prays to God for the ability to be a predictor, and when he/she receives the ability, he/she goes back to the place where the ritual happens, and tells people fortune.
3. *Hu-tn Gut* for Wave Field Synthesis System : shamans invite all kinds of souls, lower level of the gods, and demons to the place by playing metallic instruments and holding the branches of tree, then serve food, play music, and dance to please them, and take them away with playing music.
4. *Jac-Doo-Ta-Gi* for Wave Field Synthesis System : when the person is possessed by God, he/she steps on two big swords to prove that they are possessed, jumps and dances on them.
5. *Ma-Dang* for Wave Field Synthesis System : after all processes are finished, those people, who attend the ritual, gather outside, celebrate for the shaman, donate money, have food, and dance together. People call other kinds of gods, who could not come in

to the shrine, to comfort them. A lot of different kinds of performances go on during the whole process.

4.2 Musical structure and the Holomovement

4.2.1 *Between*

Background

Normally, a ritual is performed because of a certain reason or purpose, which determines the characteristics and functions of the ritual and its way to process. Audiences in the ritual might be related to the purpose too; they attend the ritual because of their own issues, not just to watch the process. During the whole process, each of the audiences' senses makes a certain 'atmosphere' in the place. This atmosphere often unite, -or is united by- their consciousness. It is called in psychological term, 'group consciousness.'

It is reported in the department of Anesthesiology at Cambridge University that when the status of being unconsciousness turns into that of being consciousness, the cortical areas of human brain make oscillations around 40Hz. When occurring, one is able to receive information and to

recognize the fact that it is not a dream, but the real. (Joliot, Ribary, and Llinas 1994)

The basic reason for selecting 40Hz as an important element is to assume that in the state of 'group consciousness' in any moment of a ritual, the consciousness of people in the ritual could be on the border 40Hz-between unconsciousness in any moment. Each of the people's consciousness is gathered and becomes a group, and this group of consciousness actually makes the ritual as a 'ritual' (sometimes a concert, a performance, or a religious assembly). One of the important facts is that this united group consciousness creates the energy that determines the atmosphere mentioned above.

Holomovemental aspects

While each of the sequences in the ritual performs different functions, it flows as a whole performance. In other words, each sequence enfolds its own function and meaning, it is unfolded by the performance as a theatrical form, and it becomes a whole movement. The Holomovement, which carries Enfoldng/Uneolfind orders can be the whole atmosphere that carries all consciousness together and creates the whole ritual. Additionally, it is hard to say that there is a clear distinction among shamans, performers, and listeners as in a general concert type of performances, which normally have clear divisions between the performer and audience. However, in a ritual, even the main performer, the shaman, has to deeply listen to music since the music has a strong function for the shaman to get into a trance. The audience takes a part in the ritual as well. They not only participate, but also sing, dance,

talk, and pray together with the shaman. Until the ritual continues to a certain climax moment, several sequences are following. Although each sequence is different, the whole is flowing to a certain level. At a certain moment, all (audiences, performers, and shamans) are combined and 'connected' together and become 'one', and there is no 'between.'

In this piece, this whole phenomenon is used as a metaphor. The movements of cello sounds reflect that audiences' consciousness is gradually and passage by passage moving onto the border 40Hz, not actual 40Hz (40Hz is between D-sharp and E, and because cello cannot make such low frequency, an octave above the first E-flat is used as the main note.) but related to it in the way of processing cello sounds. The electronic sound from the computer by the cello sounds as input sources show how close they are from the borderline of consciousness gradually.

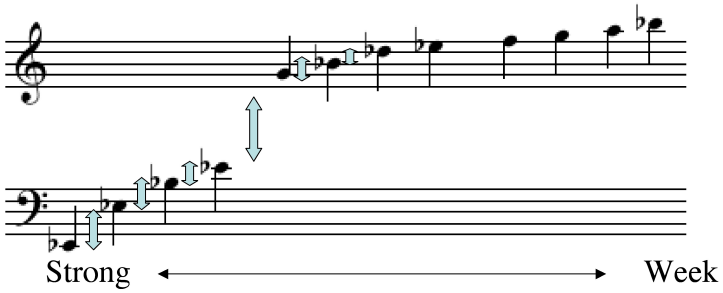

Figure 4.1: *Between*'s pitch groups by 40Hz overtones

In the musical structure, it consists of the sequences of phrases, which have a similar musical movement in between. The notes played by the cello are divided into two groups; E-flat's overtones in Figure 4.1 and the others in the middle of them (blue arrows in the Figure 4.1). Each

note shows unstable motions with a slight glissando, which is written on the score, and varying dynamics except when notes are on the E-flat group. The other notes have the tendency to become involved to the E-flat pitch groups.

Spectral delay-feedback system as an Enfolding/Unfolding process

All partials above the fundamental note are divided into several groups, and each group is controlled individually and stays in a space with different time duration according to the 'Spectral delay-feedback system' implemented with Max/MSP in computer. Its behaviors are dependent on the fundamental frequency of a note and its dynamic, and there is no any other input signal as to control. In the figure 4.1, the closer the note toward the first E-flat, the stronger dynamic it has, so that it creates more overtones, more groups and behaviors.

The details of the spectral delay-feedback system are following: when the microphone detects cello sounds, the system processes the sound in real-time. This system basically analyzes the spectrum of incoming sound with FFT (Fast Fourier Transform), and makes groups of the bins by the preset (Figure 4.2). Since each group has a different delay duration, the tails are created. Those delayed sounds have each different feedback duration again, so that some of the bin groups stay longer, and some disappear sooner. As in Figure 4.3, there are three delay-feedback lines in total. Sometimes only one line is applied, and sometimes all three lines are used according to the musical structure. All set of time durations of the delay and feedback lines are predetermined, and following to the score, the presets are changed in real-time.

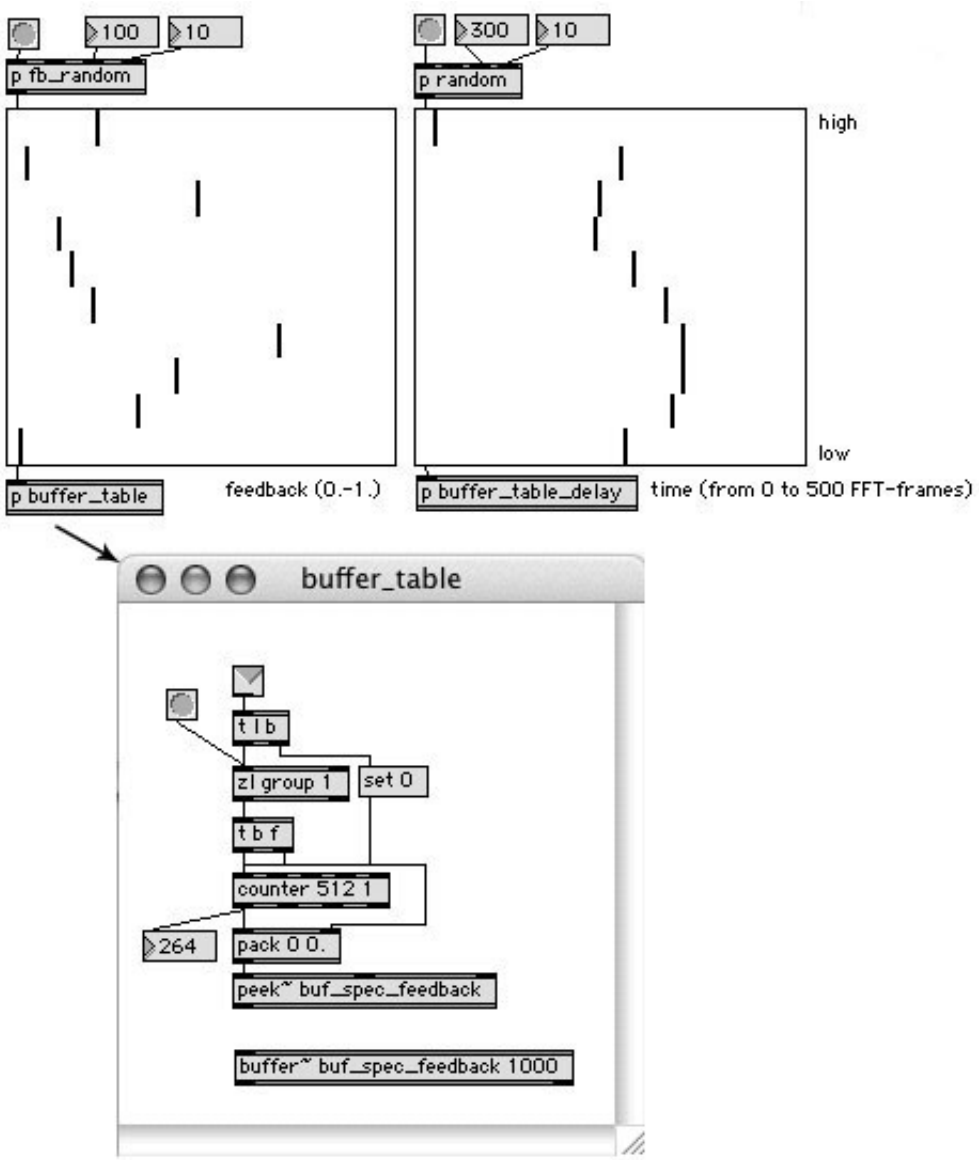

Figure 4.2: Groups of bins with the preset in MaxMSP

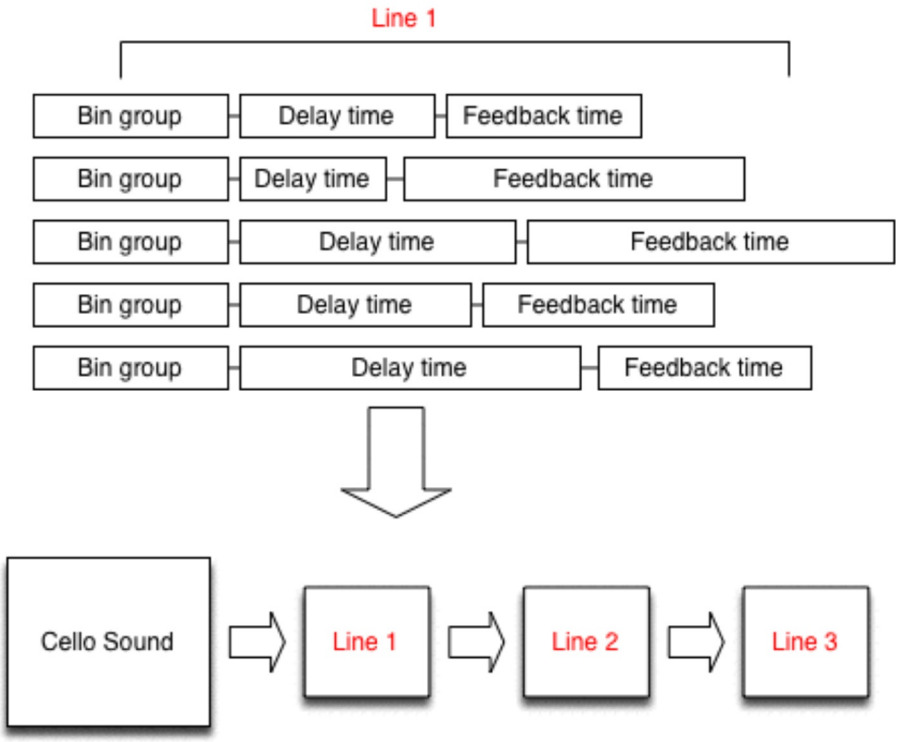

Figure 4.3: Spectral Delay-Feedback System Block Diagram

According to the feedback lines, the tails sound like a certain type of 'arpeggio' as if the pitch rises. Also, the panning is set with different behaviors: mainly with the goal to spread the arpeggio-like sound by the system into the whole room and to make the room filled by one sound and its 'shadow.'

Due to the several delay-feedback lines, each group creates a different time phase, but they are moving together with the similar behavior. The result coming out from the system by playing a note is producing the tails, which sound like one rising note (or a group).

When a sound is analyzed by FFT and creates the groups, it can be said that the sound is enfolded (into the system) and unfolded as a different group to make a different behavior. However, since this behavior has the same root, the pattern and time phase is analogous so that it create an Enfolding/Unfolding movement by each different state which are generated by the delay-feedback lines of the system and the physical movement by panning system. The behavior exists with the initial sound and gives articulations above it. All sounds moves, develops together, and goes to a certain moment where there is no between anymore.

4.2.2 *Open Your Words*

Background

This piece represents the first part of the ritual as mentioned above. Recorder represents the human area. It acts as a symbol of both the prayer and the state of shaman from being as a human to being as one who has a special ability that makes it possible to communicate with invisible existences. Jing ('Jing' is a Gong-like instrument in Korea, and is used for any type of folk music and ritual music. This instrument is the symbol of 'wind' since it has strong low frequency resonance area, and it encompasses other sounds.) represents the door to the spiritual world, the connector to God, and the symbolic way how God responds.

This piece consists of three parts; the first as an introduction and development of recorder's musical movement, the second as a transition, and the last as a cadence. The first part has a repetitive motion of the recorder's phrase in which the movement of the center note moves, and jing accompanies the recorder's movement. There is a development that the motion of the recorder becomes stronger, and faster and goes to more abstract level. At the same time, jing's movement is following to the recorder and becomes more present. The sounds coming out from computer is the one that symbolizes the communication between the shaman and God, and from the middle part of the first part, the low frequency sustained-sound is growing up, which represents that the payer of shaman is getting stronger. Then, the transition happens. Recorder and jing show a liberal and strong improvisation with exchanging each other. This transition means the 'transition' of the shaman's state by receiving the ability. After that, jing gives a strong solo improvisation and leads to the third part that recorder plays a relief with a flowing melodic

movement.

Cross synthesis as an Enfolding method and its Movement

The first enfolding aspect in this piece can be described with the recorder and jing's cross synthesis processing according to the dynamic structure. As recorder and jing have its own musical development by repetitive motion behaviors, at the same time the dynamic structure made by both instruments makes a role to create the third movement united by the dynamic of both instruments by computer processing. This movement makes a connection between two different instruments and their behavior, and at the same time it creates its own development so that musically it creates a complexity that gives more effects to the evolving movement. As Holomovement is the method to carry an Enfolding order to be unfolded, the cross synthesis acts as a method to connect two movement together and lead them to develop (or to move to a certain point), and at the same time it shows its own movement. The conceptual idea is that the processing sound by computer means both responses from God and changes of state of the shaman.

Holographic Representation with Granular Time-stretch of Bin groups

Another enfolding factor can be the background sound made by granular synthesis of the bins of jing sound and its time-stretching process. Since jing has a wide frequency range and a rich low-frequency area, it is very suitable to create powerful, strong sound units by this processing. 'Bins' can be seen as 'inner' structure of a sound. Each bin's characteristics are dependent on the constitution of sound. In other words, according to the factors that decide timbre of a sound, such as resonance, bins'

characteristics are changed. On the other hand, chopping one sound source with tiny time duration makes 'grains' so that the quality of each grain is decided by where the fragment is located in time and the window size. In other words, according to the figure of a sound by the way of making sound from an instrument, grains' characteristics are decided. Barry Truax describes about granular synthesis:

> *"The fundamental paradox of granular synthesis -that the enormously rich and powerful textures it produces result from its being based on the most 'trivial' grains of sound- suggested a metaphoric relation the river whose power is based on the accumulation of countless 'powerless' droplets of water. ... The complexity and dynamic quality of granular-synthesis sound makes it an attractive alternative to methods based on fixed waveforms or to re-synthesis models based on the transposition of sampled sound. Moreover, the basic unit or 'quantum' of the grain is a potentially more flexible building block for sound synthesis than the sine wave or the use of longer sequences of sampled sound. ... When granular synthesis is used to produce continuous textures, it has no resemblance to instrumental and other note-based music; instead, its sound world is more closely related to analog electro-acoustic music, but with greater precision of control." (Truax 1990)*

While bins can be said inner characteristics of a sound, grains can be described as outer characteristics of a sound. The idea came from the way to use both inner and outer elements of a sound source. When inner structure is treated separately and each has a separate motion, it might be perceived as an interference pattern of a sound. Then they mingle together, and create a manifold pattern that can be heard as a

mass of sound undulating due to the coinstantaneous inner movement by granular synthesis.

Layered and Projected Sound with Bins's Spatialization

Each group of bins has a specified localization in a space. The idea of different localization was derived from trying a different unfolding method in a space. The intermingling sound by granular time-stretching bins itself makes a specific timbre as a mass of sound. When this mass is once unfolded and stayed with other motions from another instrument, it might create a heavy background articulation and a mood, but when it stays for an amount of time, it might sound dull and static. To avoid this situation, there can be two different ways to modulate this mass of sound; one by modulating the inner structure, and the other one by localizing it in a different way. The former is done by filtering the sound mass using resonance filter, and the latter is done by different localization.

Bins are located with two different ways; the first are layered, rounded bins. Each group has different diameters, and is successively represented by musical structure. In Figure 4.4 and 4.5, it looks horizontal, but actually horizontal representation of sound in a space cannot be made with quadraphonic system. However, according to the frequency range of each bins' group, it is possible to be perceived as a horizontal column since the high frequency can feel as it places higher. It creates the effect that the mass is gradually growing up. This layered sound mass can be described as an ideal 'neoplastic' sound: planar, but at the same time behaving depth, and with no perspectival vanishing-point.

(Raaijmakers 2005)

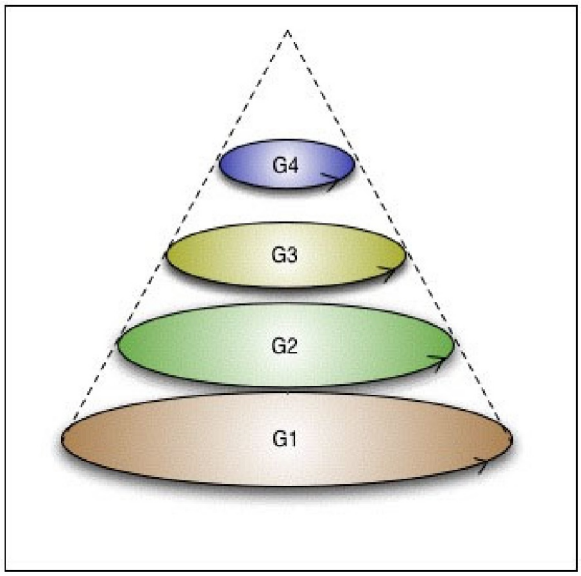

Figure 4.4: Layered bins' groups

At the transition part, in the middle of the improvisation of each instrument, those bins' layered groups have different locations and emerge from the front of the hall to the rear with increasing the level. (Figure 4.6) I call this processing 'Spatial Crescendo' since this simple processing gives more efficient impression that a sound mass comes gradually from the front with changing its weight and level according to the layered bins' group and raising its level.

The space is divided into four different zones, and each bins' group occupies its own zone (Figure 4.7), and when the projection crosses between zones, it linearly moves in order to avoid any kind of sudden change. Since each zone has each bin group, the whole sound creates

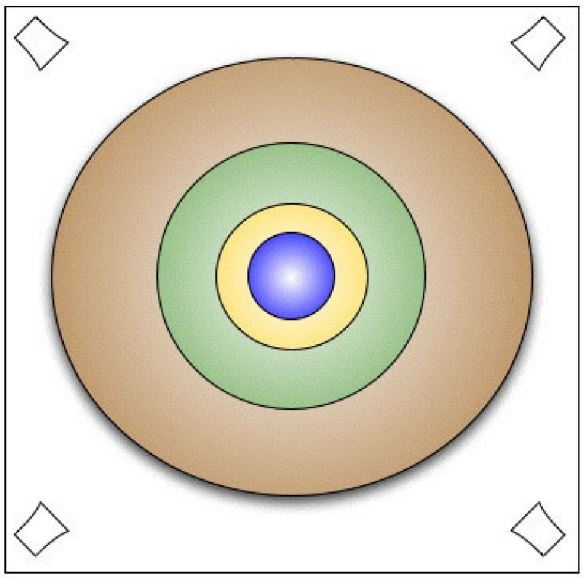

Figure 4.5: Layered Bins's Group in a hall

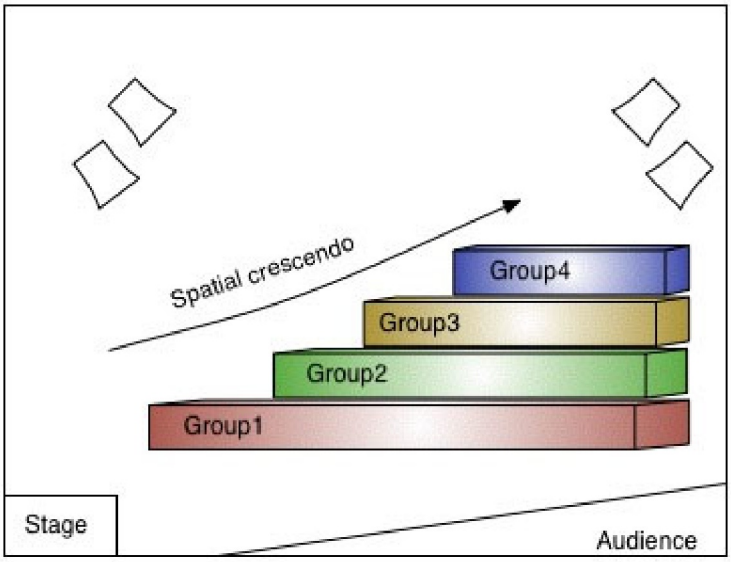

Figure 4.6: Layered Bins's Group in a hall

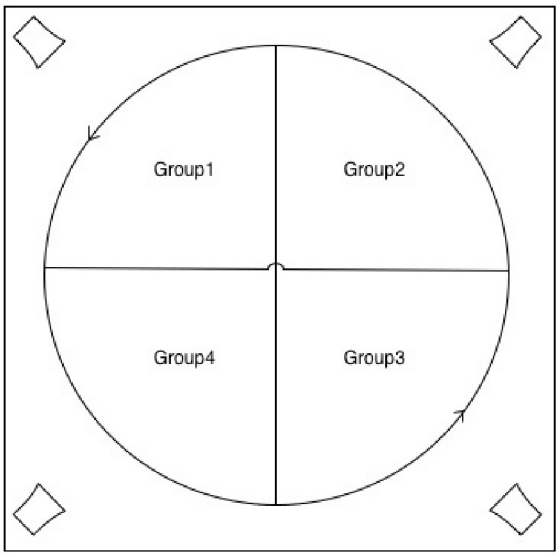

Figure 4.7: Bins'group in different zones

a wave-like result. At the last part of the piece, the resonance filter is used to enlarge the effect by narrowing the bandwidth progressively, and it gives a clearer undulating and waving impression. The point of this processing is not to create an exact shape or audible (recognizable) localization of a sound source, but to make an evolving sound mass to generate an effective undulating motion.

4.2.3 *Hu-tn Gut*

Background

The whole structure of the piece consists of three parts; in the first part, people invite all the low levels of God by playing metallic instru-

Figure 4.8: *Hu-tn Gut*in Korea

ments and drums and holding and shaking the branches of tree, in the second part, all gods come into the space and wander around, and in the last, they enjoys music and then people take them away with the music. Due to the context, mainly metallic instruments and drumming sounds govern the entire piece.

According to the context in this process of the ritual as shortly mentioned above, the main issue of this piece is the spatiality of sounds and their movement in a room. For this reason, it is composed for 192 loudspeakers of Wave Field Synthesis (WFS) System, 'Game of Life' at Scheltema in Leiden, Netherlands. (The theory of WFS is based on the Huygens principle, which states that any point of a wave front of a propagating wave at any instant conforms to the envelope of spherical waves emanating from every point on the wavefront at the prior

instant. The principle can be applied to generate a wavefront of any shape.(Ganchrow 2004))

Enfolding/Unfolding method with Layered structure with time transformation

The structure in the third part can be described as Figure 4.9. A repetitive layered sound sequence composes a stream (Figure 4.10), and each stream is evolving from another stream and creates other layers as well. As one can see, the stream is not actually a stream but a group of fragmentary particles. A particle is made by chopping a sound with different sample frames and re-shaped with applying different time durations and envelops, and putting them in different orders. A particle repeats several times, but each repetition comes differently according to the use of comb-filter. A group of particles likewise creates subordinate layers of a sound stream, which create layers of sound streams, and finally they become a sound mass. (Figure 4.11)

Figure 4.9: Structure of the third part in 'Hu-tn Gut'

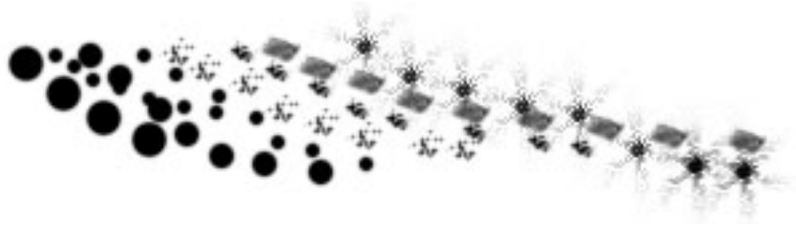

Figure 4.10: Inner structure of a sound stream of figure 4.10

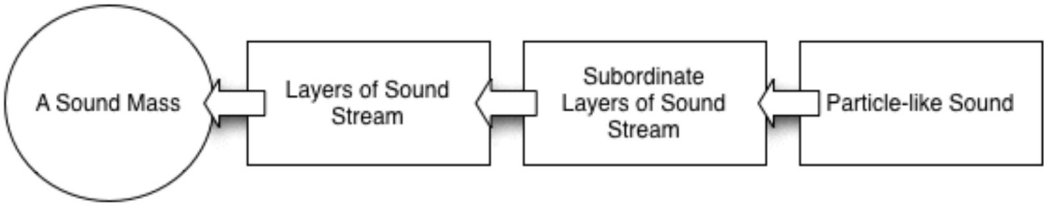

Figure 4.11: The progress of a sound mass in *Hu-tn Gut*

The issue of the sound mass is that it actually constitutes of short particles, which do not have a linear connection, so that it is hard to be perceived as a flowing movement. However, when it comes to the movement in Holomovement, the connection is not a matter to decide it as a movement, but the relationship between two particles. Each particle is derived from one sound source, is enfolded and unfolded, and creates one stream due to the similarity. The expression 'Enfolding' in this context refers to the method of basically applying different time durations ranging from 1 millisecond to 60 seconds.

Similar to the concept of Enfolding/Unfolding movement in Pierre Boulez's *Répons*, the spatial movement gives a clear action to the stream to be perceived as a movement. Although a stream itself has its Enfolding/Unfolding movement by the means of processing, its locality and actual movement of sounds in a space provide not only spatial 'move-

ment', but also the mood that is crucial to the context.

The WFS system makes possible to generate an accurate planar movement of sounds in a space. Beyond its clarity, it causes each stream of sounds to be 'alive.' The structure of the spatialization is divided into three different ways according to the musical structure.

For the first part, because of the characteristics of sound sources that are mainly percussive, each sound has its location and direction. In Figure 4.12, four yellow lines are the wave field by 192 loudspeakers, the blue spots are the locations of a sound, white arrows are the directions of sounds from a stream of speakers, and the red spots are the moving paths.

For the second part, since sounds are stretched after the phase-vocoding and have sustained characteristics, all sound layers are designed with parallel movement.(Figure 4.13) When a new sound presents, the whole stream changes its direction and speed. This spatial movement gives such impression that a mass of sound by layering groups of streams feels as a big column of sounds moving throughout the hall, and due to the speed, which is very fast, and its sudden changing of direction, one can feel a hurricane-like sense.

For the last part, more complex patterns appear. At the beginning of the thirds part, it starts with a subtle noise stream with a short time duration for each particle. It encompasses the space by turning around the hall. As in the musical structure(Figure 4.10) each sound stream comes from another stream, the movement of each stream is split from the

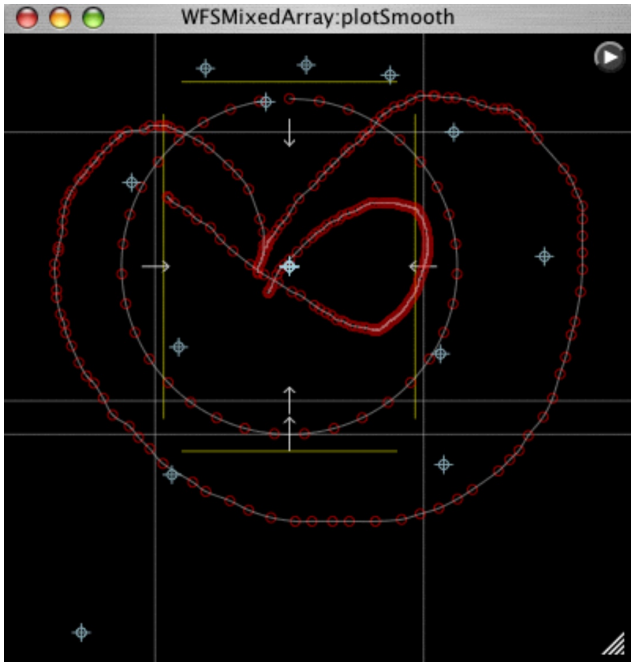

Figure 4.12: spatial movement in the first part of *Hu-tn Gut*

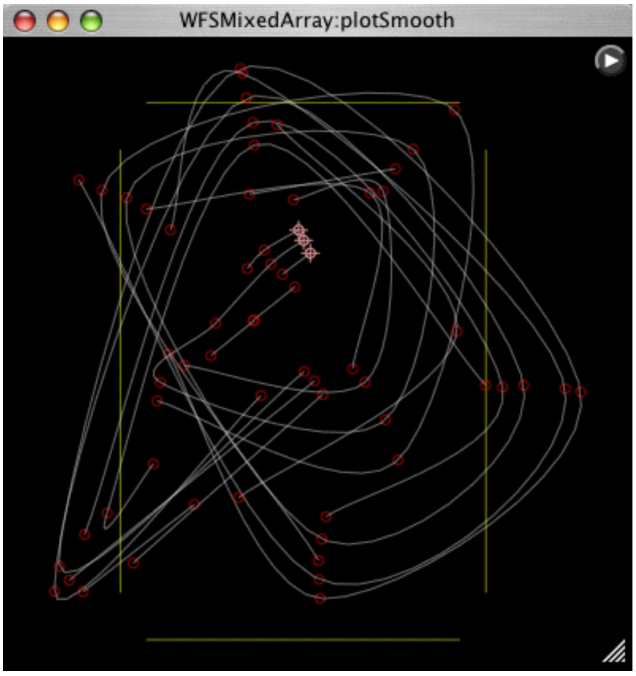

Figure 4.13: Spatial movement of the second part of *Hu-tn Gut*

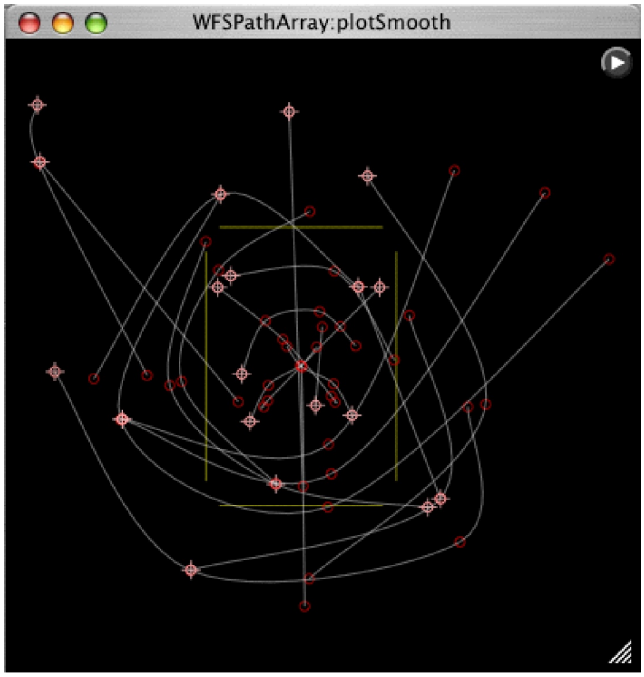

Figure 4.14: Spatial movement of the beginning part of the third part of *Hu-tn Gut*

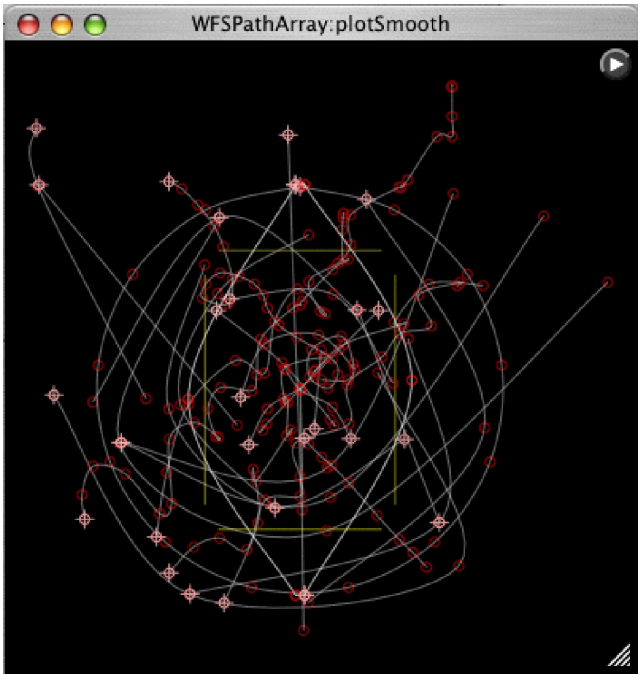

Figure 4.15: Spatial movement of the third part of *Hu-tn Gut*

stream ahead so that it creates continuity and connection.(Figure 4.14) In the middle part, there are somewhat different motions by high frequency grains that come from each corner and wandering around the space. Then, the important motions by the streams start according to the context, 'all existences are invited, and they enjoy the 'party'.' Since the groups of sound streams have the aim to be intermingling together when going through the space, all the streams come from rear part of the hall, and have spiral motion while passing through the space.(Figure 4.15) The spiral motion is used because each stream consists of particles having short and long durations with metallic and wooden drum-like characters. Therefore, when it is spiral, the space of moving area for a stream can be expanded, and at the same time, it gives more impression of sounds 'alive' than simple linear motion.

4.2.4 *Jac-Doo-Ta-Gi*

Background

Jac-Doo means a sword and Ta-Gi means to ride on. The shaman has to step on two big swords at a height of around 2 meter on the highly standing seat held by other people, and the shaman on the swords holds two long sticks to balance him/herself, and starts jumping and dancing. (Figure 4.16) Accordingly the space of the ritual during this process is also changed to outside. All the tension and excitement are raised during this process. All people feel fearful at the moment that the shaman rides on the swords, and then the tension goes away and the mood becomes energetic by the shamans dance and audiences applause. In this

Figure 4.16: *Jac-Doo-Ta-Gi* in Korea

piece, metallic instrumental sounds are used as the main materials as a symbol of the swords, and the increasing tension and the changing mood are the main issues for the whole form.

The piece is divided into three sections: the first section is the preparation for the shaman to step on the swords, the second is a reflection of the shamans consciousness that starts from fearful and nervous feeling to becoming confident and energetic, and the third is starting with the dance of the shaman and finishing with the holistic and peaceful mood.

This piece is also composed for the Wave Field Synthesis system. While the spatiality in *Hu-tn Gut* is focused on the context of the piece, that of this piece is concentrated on the density of sounds in a space. Since the concept of this piece is in general the feeling and mood during the process, the main tension of each musical phrase is differently represented with both its spatial movement and musical development.

Enfolding/Unfolding method with Layered structure with time transformation

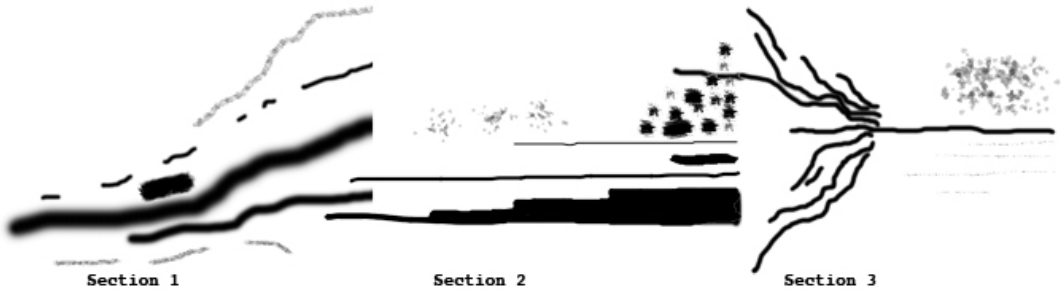

Figure 4.17: The form with layered streams of *Jac-Doo-Ta-Gi*

Similar to the methods used in *Hu-tn Gut*, the whole form of this piece is also based on layering streams of sounds, each of which is constructed with subordinate sound layers.(Figure 4.11) However in this piece, the ways of piling up the layers are different from each section, and this different methods have different musical functions.

Figure 4.17 shows the whole form of the piece with different figures of layered structure, but in each section there commonly is a main stream that holds on the entire section, and above that, there are other streams that come and go. The first section has streams both with sustained sounds and particle like sounds in a distance. In the figure of section 1, the enlarging space between the layers refers to the increase of tension and dynamic. In this section, the stream itself involves a dynamic structure becoming dense and strong by inner streams. The second section has a main stream at the bottom of the figure that increases its density generated by granular synthesis with the increasing number of grains density in time so that it creates the increasing dynamic. Different from the first section that each stream has its own dynamic, the whole tension in the second section is made by the amount of sound files following behind so that the density of musical space becomes high and it can be described with the triangle like figure in figure 4.17. The third section has the opposite direction of the movement of streams to the other two sections. However, it also refers to creating tension, and then streams are close together since the density is piling up into a certain space, which in this case means spatially gathered sounds, the range of the frequency, and the speed of sounds moving in a space. Figure 4.18 and 19 show how sounds are gathered in the center of the space. A half of the sounds are circling and developing slowly, gathered on the top, and coming into

the center. The other half of the sounds are slowly coming from the bottom part with irregular motions, and all meet at the center of the space so that at a moment, the density of the space becomes high and create a mass fulfilled with different sound streams.

Certainly what is shown in figure 4.17 is a symbolical representation; however with creating tension it gives an inspiration to be able to build a tension with different approaches to sound generation, spatial distribution, and dynamic generation.

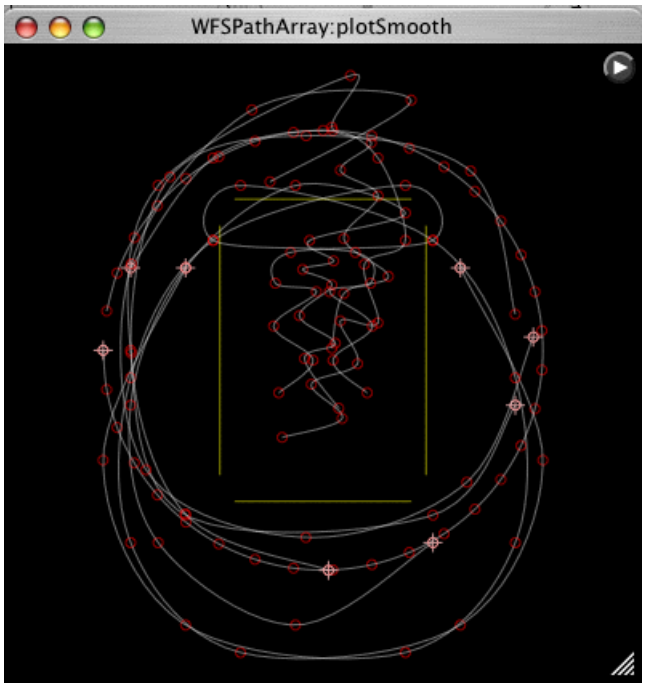

Figure 4.18: the spatial movement of section 3 : sounds coming in from the top

All sections have streams, which are similar to *Hu-tn Gut* in a sense of the method of their generations as an Enfolding/Unfolding movement. The difference between two pieces however is the roles of each

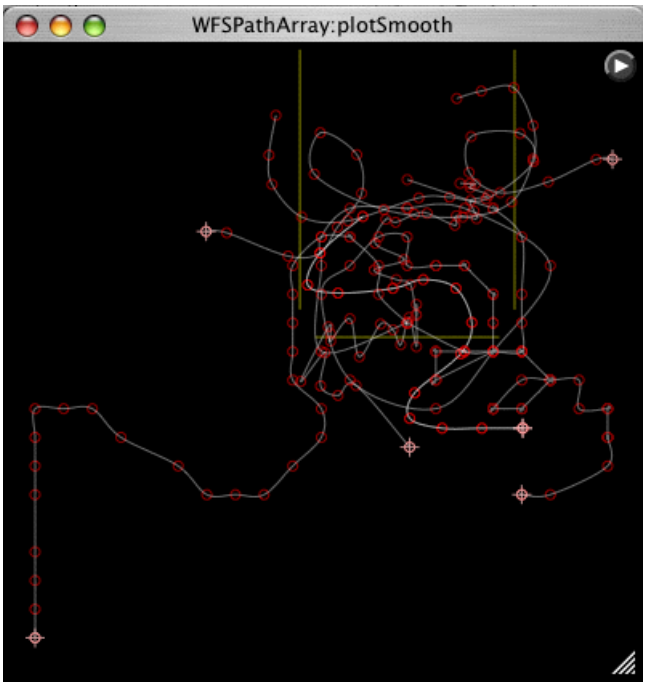

Figure 4.19: the spatial movement of section 3: sounds coming in from the bottom

stream. In *Hu-tn Gut*, when individual streams gather together, they create the whole mass. Also, they are branched from another stream. Each stream, nonetheless, does not have strong characteristics in a sense that it keeps changing and evolving its figure without a specific direction. It just comes and disappears together. In *Jac-Doo-Ta-Gi*, the Enfolding/Unfolding movement is more focused on how each stream affects the whole (inside a section). Each stream shows strong characteristics evolving in a direction, such as the frequency getting higher and open by controlling the amount of filtering, the increasing speed between sound events, and the increasing sound level, and so on. When they are together in both musical, and physical spaces, they create a more powerful mass than that of the construction of the streams(in *Hu-tn Gut*), which are comparably plain when seeing what is happening inside the

streams. They also create a higher level of complexity that sometimes hardly can follow (unfold) while listening to the mass. The whole piece does not flow as one event; it has clear divisions due to the musical concept that has been mentioned above. However, each section shows the flux of streams becoming an evolving mass, which can be seen as a whole movement.

4.2.5 *Ma-Dang*

Background

After the shaman finishes all processes needed, all attendants gather outside and celebrate the whole. We call this process *Ma-Dang Gut*. Usually *Ma-Dang Gut* happens at the end of a bigger ritual, but nowadays those rituals that happen outside are generally called *Ma-Dang Gut* as well. The original meaning of this process is to send all the Gods back, but in the bigger ritual is also to call those gods who could not be able to attend the main ritual to pacify them. Ma-Dang means a garden or yard. People prepare food outside, share it together, and donate some money for the shaman. There are a variety of different events happening at the same time; presenting plays, music, and performances.

The main issue for this piece started from the thought how to present the characteristics of this complex process of *Ma-Dang Gut*, and at the same time how to release the whole tension and the mood as a function of ending the series. Also another issue was to look for the way that

the piece can reveal as a whole movement with Enfolding aspects. The solution chosen after different experiments was to combine literally the former four pieces together.

Folding the whole as an Enfolding process

Each of the four pieces has different characteristics: *Between* with linear movements by cello, timbre extension, and the increasing dynamic for the entire piece. *Open your words* with linear movements by recorder, percussive sounds by jing, and noisy, loud, and strong moments by processing jings sounds. *Hu-tn Gut* with flowing percussive movements and structured dynamics. *Jac-Doo-Ta-Ki* with increasing tensions, sudden stops, and noisy sounds.

When combining (folding) together, the characteristics of each piece play their own roles, and they together create a clear outline because of the dynamic structure of each piece. The whole structure made by folding different sonic events and contents together can be literally said as an Enfolding process. What we are listening(the Unfolding result) is perceived differently from the characteristics of each piece since in this piece, the events happening inside each piece become different with different functions as they are bound together with those of the others. Now, the events inside each piece can be seen as microstructures that take a part in the bigger form(macro form), differently from the way they were. Thus, the result of this process creates different sonic results from listening to each of the pieces.

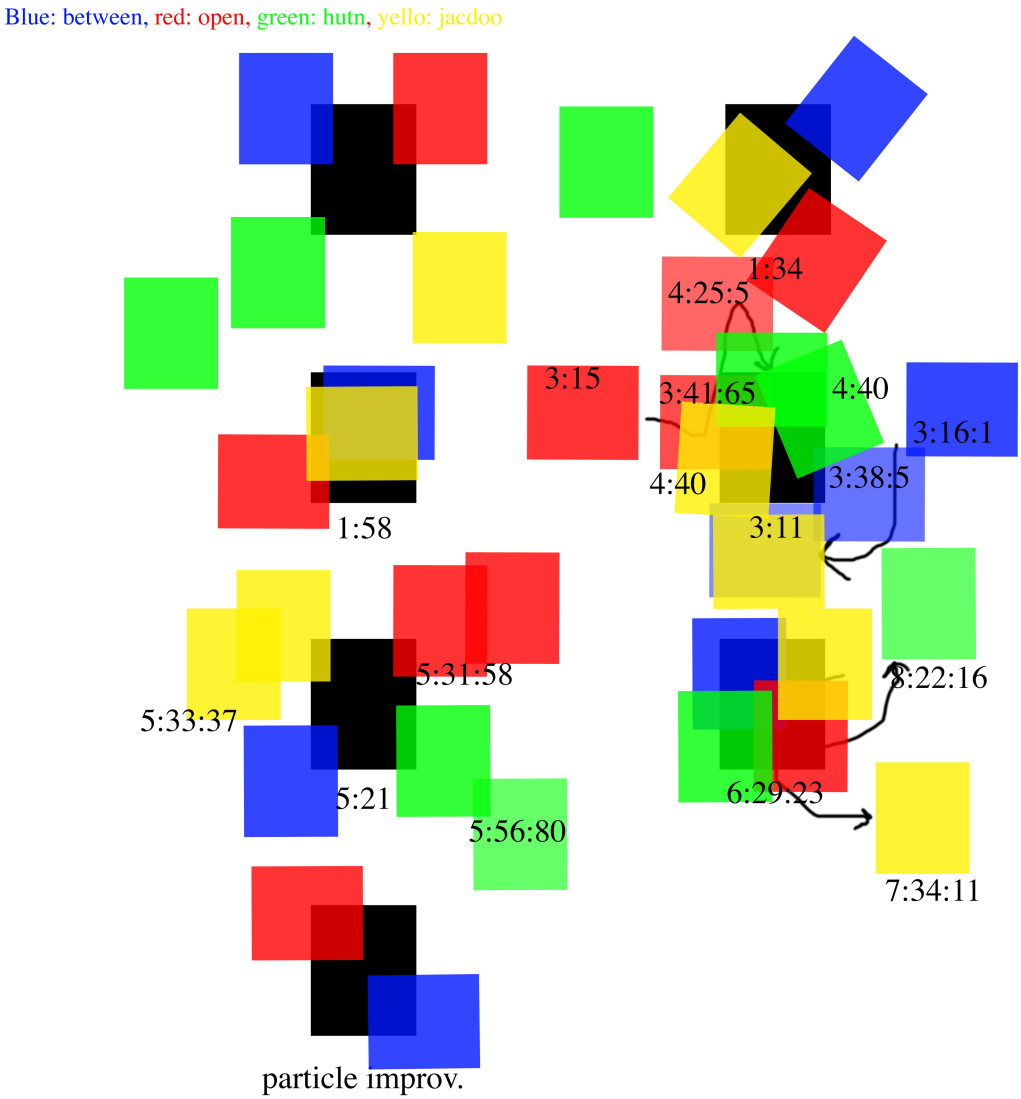

Figure 4.20: the spatial score of *Ma-Dang*

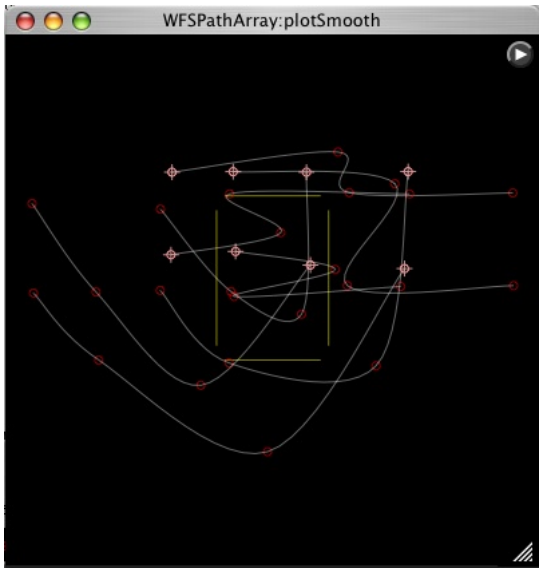

Figure 4.21: the beginning part of the spatial movement of *Between* and *Open your words*

Enfolding spaces

When it comes to the technical issue, in terms of well-balanced mixture, there was a necessity to fix the sound levels in some parts, but at the same time, it was an important issue for me not to touch each piece with another processing in order to fold them together as they are. The solution was to put them in the space together, and by differentiating the distances, the level could be changed.

The Figure 4.20 is the spatial score made for the WFS system and shows how each piece is spatially organized . The black box is the actual sound field, and the other boxes with different colors are made of 4 points of sound sources, (Figure 4.21) which refer to quadraphonic representation. In time, each box is moving into the next position, and it creates different folding structures in space, and at the same time, it gives the impression of what piece is more attentive in a given moment.

The placement of the pieces is treated as a material according to the characteristics of each piece (not as a complete music piece), and chosen according to finding a better musical representation as a whole.

In terms of the Enfolding order, it is shown that different performance spaces keep being enfolded and unfolded together and creating different occasions from the actual state of the musical characteristics of each piece. Even though each performance space is away from another in the hall, the sonically happening phenomenon in the space is not a simple separation, but an intermingling event as a whole by the properties of the physical spatial behavior.

4.3 Summary

This chapter has showed the possible ways to apply the Holomovement and its Enfolding/Unfolding aspects in electronic music composition. As mentioned at the first chapter of this thesis, the application of the Holomovement theory is not to generate its characteristics in a provable way, but to use it in a metaphorical level as both the compositional and technical materials.

The Enfolding elements used in my electronic music pieces are ranging from a particle of the sound object (*Open your words*), the inner structure of sound (*Between*), and the time structure of a sound object (*Hu-tn Gut* and *Jac-Doo-Ta-gi*), the spatial localization of a sound. (*Hu-tn Gut*, *Jac-Doo-Ta-gi*, and *Ma-Dang*) Those elements are chosen to create their continuous unfolding movement for which different methods were used.

Each different Enfolding method for the elements was applied first to fold the inner structure of sounds and then to unfold them to create another musical phrase. In spec-

tral manipulation, each of the Unfolding state is different from the previous one, but it keeps its characteristics. (e.g. *Between* and *Open your words*) Spatial folding structure of layers of sounds are used to create a dense structure in a room (e.g. *Hu-tn Gut* and *Jac-Doo-Ta-Gi*) Together with it, the horizontal enfoldment created by manipulating the time structure as a layered structure of sound is one of the Enfolding method as well to create a continuous movement. (e.g. *Hu-tn Gut* and *Jac-Doo-Ta-Gi*) Also, in a space, folding different spaces together such as several performance spaces can be used as an Enfolding method.(e.g. *Ma-Dang*)

The main characteristics with those methods that are effective in electronic music composition can be summarized as follows:

1. It can create a continuous musical development, a flow, with sequential behaviors and patterns.

2. It can be useful to create a mass of sound (both in musical phrase and spatial distribution) slowly evolved by several events with similar gestures.

3. It can create a united timbre/rhythm/spatial configure by reorganizing itself in the entire music piece.

4. It can generate multiple spaces in a space by superimposing different spaces with different properties.

As any method in musical representation has a direction by a composer's idea, the Holomovement theory and its components gave a specific way of organizing and generating materials in composition.

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Appendix

Contents of the CD

Nea-Rim Gut, A series of Electronic music pieces(2006-2008)

1. *Between* for Cello and Live Electronics (2006)
   -Cello by Amber Docters van Leeuwen
2. *Open Your Words* for Recorder, Jing, and Live Electronics (2007)
   -Recorder by Min-Seok Kwon
   -Jing by Sang Mok Oh
3. *Hu-tn Gut* for WFS (2007)
   -Stereo version
4. *Jac-Doo-Ta-Gi* for WFS (2008)
   -Stereo version
5. *Ma-Dang* for WFS (2008)
   -Stereo version