

Melodic Variations: Toward Cross-Cultural Transformation

by

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Abstract

We all share similar innate emotions, but our cultural experiences nurture us to express them differently. The musical form "theme and variations" offer us a unique lens to uncover in each culture the relationships between the musical surface that touches us most directly, and the underlying structures that are more abstract. Variations are musical surfaces composed to explore the expressive potentials of the theme by transforming it along certain musical dimensions, while the theme itself can be seen as an intermediate pathway to the more abstract structures of a style.

I approach cross-cultural transformation in music as a kind of cross-cultural variation, as the theme and variations tradition offers us a framework to explicitly consider which musical elements to stay fixed and which to vary. I propose to treat cross-cultural variation as a four-step process. First, the process of "melodic reduction" reduces the melodic surface of a theme to its underlying melodic progression. Second, "forward cross-cultural transformation" maps the uncovered progressions to those idiomatic in the cultural style that carries the variation. These cross-cultural mappings are approached by considering which of the melodic properties in the underlying progressions to preserve and which to transform. These properties include contour, scale-degree function, melodic formulae and tension. Third, "melodic elaboration" retrieves the melodic surfaces that possess the mapped melodic progressions. Fourth, "backward cross-cultural transformation" adjusts the melodic surface of the variation to strengthen its resemblance to the theme.

My experimentation begins with the melodic variations on two historically related instruments, the Chinese zither, gu-zheng, and the Japanese zither, koto. Even though their repertoires evolved culturally to render very different melodic surfaces, it has been pointed out by ethnomusicologist Alan Thrasher that there is a high degree of similarity between their underlying structures. This enables a cross-cultural mapping at the structural level that ties together stylistically different melodic surfaces to exhibit a kind of cross-cultural variation. I will conclude by briefly discussing the effectiveness of variation as an approach to cross-cultural transformation.

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CHAPTER 1

Introduction and Background

Many of our emotions may be universal, but how we express them can be very different. To convey our thoughts and feelings, we often prefer a medium that is most natural to us. For some this may mean writing a novel, while for others it impels the need to compose a programmatic symphony. Although the messages being communicated through these two modalities may be very different, the successions of tension and relaxation felt could be similar. Throughout history, we have employed different stylistic idioms to express these successions of emotions. In addition to being realized in various mediums during different periods of time in history, expressions are also being rendered in diverse cultural contexts.

Can expressions created in one culture transcend cultural boundaries and be communicated and shared across cultures? In cross-cultural transformation, are we seeking cross-cultural equivalence, adaptation or variation? What degrees of similarity are we seeking? What do we want to preserve, or is our goal to go beyond the original, to explore the creative potentials by expanding our range of expressions and emotions to those unfound in one's culture.

Is cross-cultural equivalence possible? For example in literature, translation attempts to approximate this equivalence but faces the struggle between literal equivalence and conceptual equivalence. In order to communicate the original intentions, a thorough explanation of the cultural and historical context with all the symbolisms, imagery and expectations would be required, but this would interrupt the flow of the text, especially in poetry, or the focus of the plot. Other translations rely on cross-cultural analogies to create a parallel world in another cultural context, by uncovering the signified behind the signifier in one culture, and mapping it onto the signifier of another culture. But does this semantically convey all the desired sentiments and does it effectively arouse the same kinds of affective mental states? On the other hand, do two people, even from the same culture, ever share the same exact reading of a text? Readers themselves often create their own context and elaborate the story with their own personal experiences and memories. Hence, even if we can not find the perfect match across cultures for the author's expressions, one may first try to uncover the central idea, and then interpret it and elaborate it according to their own perspectives.

Hence, the best of translations go far beyond pure translations, and creates a whole new experience of chemistries. Such an attempt is seen in adaptations.

What does it mean to transform music across cultures? What are we transforming? What kind of musical idea? To address these questions, I treat cross-cultural transformation as cross-cultural variation.

1.1 “Theme and variations” as analytical framework

This thesis uses the concept and tradition of variation in music as an analytical framework for introducing, motivating and addressing some of the central issues in cross-cultural transformations.

First, in the western tradition of music variations, themes are often borrowed across styles, although still within the broader tonal context.

Second, variations explore the expressive potential of a theme along many different musical dimensions, and more recently, cultural idioms have become a natural expansion in the variation palette, especially in jazz improvisations of elaborate variations on a popular theme, which is fundamentally a multicultural expression, being the fruitful result of decades of constant expansion of expressions and experimentations.

Third, variations by its very nature grapples with the identity of a theme, not necessarily its authorship or ethnic origin, but to what degree it is perceivable in the variations for the listeners to identify that there does exist a theme and how it relates to each of the variations and ties the whole piece together. This involves identifying the salient characteristics of a theme. What aspects of the theme can be varied with the theme still retaining its identity, and what has to stay fixed? The answers also depend on the kind of role played and overall function served by the theme in a piece. To answer these questions require going beneath the musical surface to a deeper structure, as variations are not only based on the thematic quality of a theme, but also its underlying melodic and harmonic structure. In cross-cultural transformations, these issues become front and center. As the musical languages differ drastically, varying a theme from one culture with the stylistic idiom of another culture presents a great challenge in maintaining the perceptual identity of a theme. The deeper structure of melodic and harmonic would no longer be sufficient in maintaining coherence across cultural variations, as the melodic and harmonic vocabulary and syntax differs across cultural idioms. This may require us to go into deeper layers of structure where there is a more universal language. But the further we go, the more abstract it becomes and the less direct connection there is on the musical surface. Can we find a balance between perceptual coherence and cross-cultural analogy?

Background

In order to provide the general MIT audience with a point of reference before embarking on the journey of this thesis, I start with one of the most familiar and influential thinkers at MIT, Marvin Minsky, in his discussion of the significance of musical forms, in particular, the "sonata", in our listening experience, and extend his line of thought to provide a conceptual description of the musical form "theme and variation", and explain how it teaches us to discover deeper structures in music. I will follow by introducing the long tradition of "theme and variation" in the western music history, and then go into more details of what defines the form, and its musical function. I then proceed to introducing the solo repertoires for the Chinese gu-zheng and the Japanese koto based on their resemblance to the western repertoires in terms of variation techniques.

1.2 Form as a teaching machine

In Minsky's AI Memo No. 616 to the MIT Artificial Intelligence Laboratory community addressing "Music, Mind and Meaning", Minsky (1981) describes the sonata as a teaching machine. Composers start simple by presenting their basic musical ideas in the exposition. These ideas are first rendered as motives akin to atoms with impending chemistries and the exposition shows how some simple compounds can be made from those atoms. In order not to lose the students who may be new to the subject, composers repeat the basics several times before presenting anything larger or more complex. Then, in the developments, "those now-familiar compounds made from bits and threads of beat and tone, can clash or merge, contrast or join together". The listeners now "own new networks of knowledge about each theme and how it changes and relates to others", and is ready for the recapitulation to put everything in perspective.

Theme and variations can also be treated as teaching machines. Composers program these machines to showcase a theme along different musical dimensions. By starting with simple melodic elaborations and rhythmic figurations, composers slowly stretch their listeners' ability to reason how the varied restatements relate to each other and progress towards varying deeper structures.

1.3 Theme as pathway to deeper structure

Theme and variations offer us a unique lens to uncovering the relationship between the musical surface and deeper structure. Variations are musical surfaces composed to explore the expressive potentials of the theme by transforming it along certain musical dimensions, while the theme itself can be seen as an intermediate pathway to the deeper structure, as illustrated in Figure 1-1. As Burkhart (1994) puts it in his "anthology for musical analysis",

“the theme is itself an elaboration of a basic melodic and harmonic substructure - the key to the variations” (p.177).

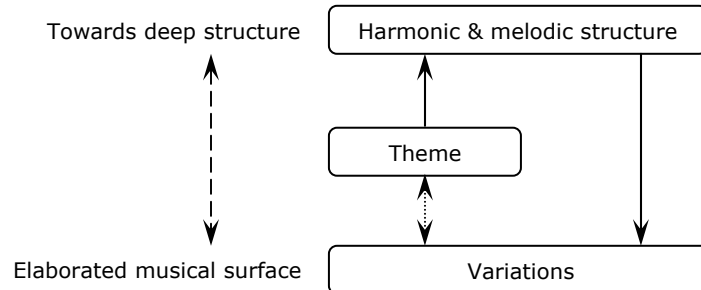


Figure 1-1: The existence of a deeper structure beneath the musical surface of the theme and variations.

After initial sketching, composers consciously or unconsciously work with the harmonic and melodic structure of the current theme to create variations, providing a common grounding for the two, as indicated by the solid arrows in Figure 1-1. As in any creative process, our mental processes are never mono-directional, and there are often feedback interactions between the individual parts. As new ideas for variations are generated, the composer might realize the fundamental harmonic and melodic structure needs to be modified in order maintain inner coherence, consequently adjusting the original theme.

Listeners on the other side, start from the musical surface. They hear the variations in reference to the themes (as indicated by the dotted arrows in Figure 1-1), realize some degree of resemblance, and gradually discover the underlying deeper structure.

1.4 Variations as perspectives

“So something has a “meaning” only when it has a few; if we understood something just one way, we would not understand it at all” (Minsky, 1981). Music composed in the form of theme and variation offers us the opportunity to listen to a theme in multiple ways. By experiencing how a single theme can be transformed into variations along many different musical dimensions, we understand the expressive potential and the inner workings of the underlying musical structure.

Each variation is a composer’s perspective on the theme and the underlying musical structure. To elaborate a theme, the composer deliberately chooses to magnify certain musical features while disguising others. This allows the listeners to enter the musical surface through a different angle, and to hear the underlying structure in a different musical context.

Being presented with the same theme, composers from different cultures would find different aspects of the theme intriguing and decide to foreground certain characteristics while transforming others, presenting a cultural perspective of the theme. Cross-cultural composition invites new ways of understanding music. By including cultural stylistic idioms as one of our musical dimensions for variation, we can expand our expressive palettes.

1.5 The tradition of variation

The musical form "theme and variation" has been attempted by nearly every prominent composer throughout the history of western music, both composed and improvised. It dates back to the Renaissance as a variation technique described as 'divisions on a ground', in which the improviser would successively divide the basic rhythmic beat of a recurrent ground bass (provided by a harpsichord or another instrument) into smaller and smaller values to provide a counter-melody (McVeigh).

In "A history of music in western culture", Bonds (2003) traces the roots of music variations to the orators of the Renaissance.

"Orators of the Renaissance, following the ancient models of Cicero and Quintilian, placed great value on the ability of public speakers to embellish the expression of an idea in different guises, varied in such a way as to both please and move an audience. Composers went about their task with much the same goal, shaping each restatement of a given theme in such a way as to delight and move listeners."

In Green's book on "Form in tonal music", Green (1965) introduces the form "theme and variation" as "small forms ... expanded into longer pieces by the principle of varied repetition. A theme is stated, then repeated a number of times, each time in a new guise" (p. 98).

A theme and subsequently the piece that it seeds can be further described by considering the following five aspects:

- 1) The source of a theme: Did the composer borrow a well-known tune or compose an original theme?
- 2) The property of a theme: Is the theme a melody, a bass line (ground bass/ basso ostinato), a harmonic progression (chaconne) or a complex of such elements (Sisman, 2001)?
- 3) The function served by the theme: Do the variations "follow the original "tune" closely, or do they only make the briefest reference to it, sometimes harmonically rather than thematically" (Ed, Kennedy)?
- 4) The form encouraged by the theme: Is the theme self-contained, inviting "sectional variations" with unambiguous demarcations between the end of the theme and each variation, or is the theme rather brief, comprising only a

phrase or two, and naturally motivates “continuous variations” which follow each other uninterruptedly (Green, 1965)?.

5) The subsequent function of the form: Does the set of variations occur as part of larger work, or do they form an independent composition?

Not all of the combinations across the four criteria are equally probable, due to the nature of the musical materials and prior bias from the variation tradition. For example, a variation on a bass line usually manifests itself as “continuous variations”, serving as the ground bass (basso ostinato). Its repetitions generate a continuously unfolding structure with new figurations and textures at each statement of the theme (Green, 1965). Other common “continuous variations” include the chaconne and the passacaglia.

One of the masterpieces at the pinnacle of the form “theme and variations” is Johann Sebastian Bach’s “Goldberg Variation”, as shown in Figure 1-2, composed for two-manual harpsichords. After a statement of the aria at the beginning of the piece, there are thirty variations. The theme, setup by the composer, has a bass consisting of slow-moving notes mainly constructed from segments of the downward scale. The bass line serves as the glue for further melodic variations that introduce new melodies. The bass line is first varied with more simple variations such as ornamental and figurative variations, and later modulates to the relative minor (variation 15).

The image displays four staves of musical notation for the bass line of the Goldberg Variations. The first staff is labeled "(BASS)" and shows the original theme in G major, 3/4 time, with a sequence of notes: G2, B1, D2, E2, F2, G2, A2, B2, C3, B2, A2, G2. The second staff, labeled "VAR. 1", shows a variation with a more active rhythmic pattern. The third staff, labeled "VAR. 3", shows a variation with a different meter (12/8) and key signature (D major). The fourth staff, labeled "VAR. 15", shows a variation in the relative minor (E minor) with a 2/4 time signature. The fifth staff, labeled "VAR. 17", shows a variation in the relative major (D major) with a 3/4 time signature. Each variation is marked with a "+" sign below the notes.

Figure 1-2: Bach, some bass lines from “Goldberg Variations” (score excerpt from Green, 1965)

One of the most popular themes for variation is Niccolò Paganini’s twenty-fourth caprice, as shown in Figure 1-3. Some variations bring the theme outside of its immediate stylistic idioms into realms that draw on cross-cultural references such as Fazil Say’s “Paganini Jazz”, described as

“Variations on the Caprice No.24 in the style of Modern Jazz” in “The Virtuoso Piano Transcription Series” of Schott Music, and David Baker’s “Ethnic Variations on a Theme of Paganini” for violin and piano.

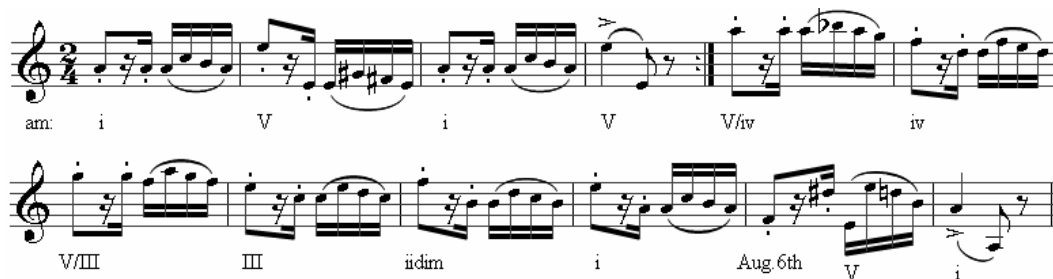


Figure 1-3: Paganini, Twenty-fourth caprice, theme with implied harmony (score excerpt from Ahn, 2000).

There are certain characteristics of the Paganini’s theme that invites such attention and creativity. A diatonic melody allows a composer more room for incorporating ornamental gestures. Paganini’s theme is used not only as a theme, but also a skeletal framework that suggests a slow and simple harmonic scheme which allows much space for harmonic elaborations. Furthermore, a binary form offers an opportunity for change in the repeated section (Ahn, 2000).

Side note: In the western tradition, the term “melodic variation” refers to a kind of variation where the bass and the general harmonic scheme remains intact through the variations to provide cohesion, while freeing the melody from being the glue, thus inviting variations to introduce new melodies for variety.

In this thesis, I refer to “melodic variation” as a monophonic piece consisting of a melody as its theme, and the variations are composed upon the thematic and melodic structure of the theme.

1.6 Melodic variations on the Chinese gu-zheng and Japanese koto

The solo repertoire of the Chinese gu-zheng is particularly suitable for the experimentation of cross-cultural transformation. First, they are melodic theme and variations built upon the structural templates of ancient melodies (qu-pai, literally named tunes), akin to the cantus firmus in the western tradition, revealing yet a deeper layer of structure than the themes of the individual pieces (Figure 1-4).

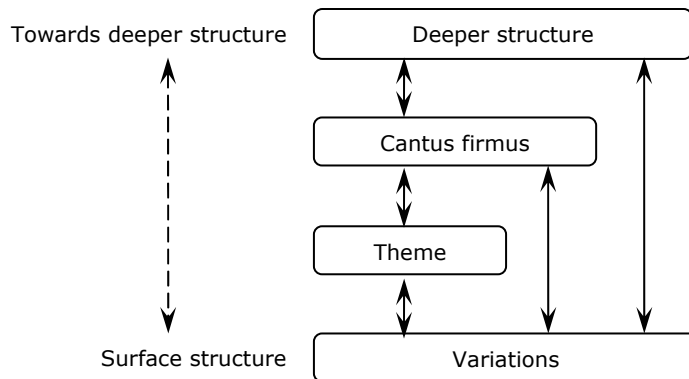


Figure 1-4: The cantus firmus reveals yet a deeper layer of structure than the themes of the individual pieces.

Second, the gu-zheng has a close relative in the Japanese culture, the koto, which possesses a solo repertoire that exhibits a high degree of similarity in form to the gu-zheng repertoire (Thrasher, 1995), allowing the potential for cross-cultural transformations (Figure 1-5). Since in both traditions, new pieces are composed by adhering to melodic models with well-defined structures, creativity is focused and exhibited on the melodic surface through variation techniques. One of the most prominent variation techniques, particularly in the gu-zheng tradition, is to subdivide beats and then interpolate melodic notes between the beats.



Figure 1-5: Two phrases from the Japanese *Rokudan* (top stave, transposed up a minor 6th) juxtaposed against the Chinese *Chu Shu Lian* and its cantus firmus (bottom three staves, transposed up an octave).

The Japanese variations are technically mutual variations as there is no clear sense of which section is the theme and which sections are the variations. Instead, all the sections are variations upon an underlying melodic model. On the other hand, the Chinese variations are technically reverse variations, as the more elaborated sections are presented first, followed by sections with decreasing elaboration that increasing similarity to the cantus firmus. From the Figure 1-5 above, we can see a high-degree of similarity

between the Chinese cantus firmus and the Japanese variation on the structural level, thus inviting cross-cultural transformation.

When compared to the western tradition, gu-zheng music resembles how chorale preludes elaborate on pre-existing chorale melodies. Gu-zheng music also ornaments a cantus firmus, a pre-existing qu-pai (literally named tune) which originates from folk songs but the lyrics were lost when the tunes were adapted for instrumental compositions. As in Bach's chorale preludes (Figure 1-6), the objective is to convert the cantus-firmus into a more florid and plastic line through elaborate ornamentation. Sometimes the notes of the original cantus firmus are shifted, with ornamental pitches on the stronger beats, as in Brahms's chorale prelude (Figure 1-7), so that the original melody is somewhat hidden or disguised.

The image shows a musical score excerpt for Figure 1-6. It consists of four staves. The top staff is labeled 'C.F.' and contains a simple melody in G major, 4/4 time. The second staff is labeled 'Man.' and shows a highly ornate piano accompaniment with many sixteenth and thirty-second notes. The third staff is labeled 'Ped.' and shows a simpler piano accompaniment. The bottom staff is a bass line with a few notes.

Figure 1-6: Bach, *Wenn wir in höchsten Nöthen sein*, Vol. V, No. 51 (score excerpt from Kennan, 1999).

The image shows a musical score excerpt for Figure 1-7. It consists of three staves. The top staff is a cantus firmus in G minor, 6/4 time. The middle and bottom staves show a piano accompaniment with many sixteenth and thirty-second notes, creating a dense texture.

Figure 1-7: Brahms, *Es ist ein Ros' entsprungen*, No.8 of Eleven Chorale Preludes, Op.122 (score excerpt from Kennan, 1999).

In the case of gu-zheng, as many pieces are derived from the same cantus firmus, in addition to ornamentation, melodic changes to the cantus firmus are often carried out in the process of producing new compositions.

1.7 Personal motivations

In addition to the structural similarity of the Chinese gu-zheng and the Japanese koto that invites the experimentation of cross-cultural transformation, there is another reason for this endeavor.

"I do not remember my first encounter with the gu-zheng, the Chinese zither. But as early as I can remember, I have always been captivated by the beauty of its music. I finally had the opportunity to be in close contact with it in middle school. I soon begin to realize that there was a certain degree of homogeneity across the gu-zheng repertoire, which at the same time seem to project itself as its unique kind of stylistic quality. And I wondered if this unifying factor was the unique timbre of the instrument, or the particular performing idioms encouraged by the instrument, or was it something underneath the sound surface, some inherent musical property that enabled/carried such expressiveness. I later became aware of the Japanese zither, koto, which had a very similar construction to the gu-zheng, but I was struck by how its repertoire carried a very different kind of sentiment, and I wondered if I could make my gu-zheng speak in such a manner." – the author.

The reflection above brings out two thematic points regarding the role of musical structure that is relevant to this thesis. The first is the importance of musical structure in discovering similarity underneath the musical surface. Not only until embarking on the journey of this thesis, did I learn that many of the most representative gu-zheng pieces are variations on the same *cantus firmus*, thus creating a structural continuity across the repertoire. This also reflects the high degree of creativity in the variation techniques employed in order to create individual pieces that each has a unique character. The second is the treatment of musical structure as a cultural aesthetic, the underlying manner on which the artistic execution on the melodic surface is delivered. For example, a melodic progression can be thought of as a characteristic mode of acting.

The last part of the reflection above regarding the Japanese koto may to some readers more strongly allude to the possibility of performing the koto repertoires on the gu-zheng, as the two instruments are of the same type. Such experimentation does seem highly plausible than the reverse, as the gu-zheng has more strings than the koto and can be retuned to cover its entire range, although the strings will not be in its optimal state of tension to create the desired timbral quality. Furthermore, some of the playing techniques that are idiomatic and characteristic of the koto are far less feasible on the gu-zheng. This discrepancy exists because the musical surfaces of the solo repertoires of the two instruments are sufficiently different. They call for unique modes of execution that demand plectrums of a specific shape, size and material.

1.8 Roadmap

This chapter opened with a brief discussion of the possible outcomes of cross-cultural transformation. Instead of seeking cross-cultural equivalences, the musical form “theme and variations” is introduced to act as a framework for approaching cross-cultural transformation as a kind of cross-cultural variation that expands our range of expressions. After a brief journey through the tradition of theme and variations, the melodic variations on the Chinese gu-zheng and the Japanese koto are introduced in a comparative manner. This thesis focuses on the melodic and structural aspects of music in order to address the central issues in cross-cultural transformation. Chapter 2 further develops cross-cultural music transformation as a four-step process that involves melodic reduction, forward cross-cultural transformation, melodic elaboration and backward cross-cultural transformation. Chapter 3 elaborates the melodic reduction process, while Chapter 4 discusses the underlying melodic formulae available for cross-cultural mapping, and demonstrates a possible mapping with a short musical example. The preceding chapters outlined the proposed and desired design of the processes, while the last chapter summarizes the current state of the implementation and points to some of the possible future work. This thesis concludes with a brief discussion of the effectiveness of variation as an approach to cross-cultural transformation.

CHAPTER 2

The Concept of Cross-Cultural Transformation

To introduce the concept of cross-cultural transformation, I first establish the meaning of the term "transformation" as both the overall concept and as the specific procedures involved in realizing such a goal.

The concept of cross-cultural transformation is developed as a kind of deep variation. The fixed and varied elements in a common-practice theme and variation are interpreted as the deep and surface structures of a theme respectively. While in a cross-cultural theme and variation, the level of structures associated with the fixed and varied elements are advanced one layer deeper due to the fundamental differences in each culture's musical system. Subsequently, a new structural level is introduced as the "hyper-deep structure". Hence, the fixed and varied elements are now associated with the hyper-deep and deep structures of a theme, and theme is varied by searching for cross-cultural analogies along different musical dimensions. Two "transformative" procedures are introduced to facilitate cross-cultural variations, namely "forward cross-cultural transformation" and "backward cross-cultural transformation".

Before further developing the conceptual framework in detail, two issues are discussed to motivate the two newly introduced "transformative" procedures. First, the possible interpretations to a cross-cultural variation to a theme would be interpreted, with respect to its stylistic identity and its relationship to the theme. Second, cross-cultural variation may give the impression of fusion, even if the processes involved and compositional goals are different. The two "transformative" procedures strengthen the cognitive persuasiveness of a cross-cultural variation and highlight the unique processes involved in such an endeavor.

After establishing its plausibility, I lay out the complete process of a cross-cultural transformation. I then relate it back to the common-practice theme and variations and discuss how it stretches the definition of variation as varied repetition. Finally, the conceptual levels of structure involved in a cross-cultural variation are mapped onto concrete musical structures.

2.1 The term “transformation”

The term “transformation” in this thesis is not to be confused with the term “transformation” in the Chomskyan tradition which converts deep structures into surface structures. In the context of this thesis, the meaning of the term “transformation” is twofold. On the micro level, I use the term “transformation” to emphasize the various processes and operations necessary when “rearranging” a melody across different musical systems. On the macro level, the term “transformation” is referred to as the concept of “rearranging” a melody into another cultural style. Nevertheless, the concept of cross-cultural transformation does embody the notion of transforming deep structure to surface structure as one of its most important operations.

The term “transformation” is used instead of “rearrangement” because the word “rearrangement” is often used in the context where a piece has more than one part, and different instruments are called for depending on the context. However, there are also stylistic “rearrangements”. For example a tune which is strictly tonal and diatonic can be rewritten in the style of Jazz. However, the elements that are preserved and the elements that are rearranged in a cross-cultural transformation differ from that of a rearrangement, and are better described by the framework of theme and variation. Hence, cross-cultural variation is one approach to the concept of cross-cultural transformation, while there can be specific procedures in a “transformation” that are employed in the realization of a cross-cultural variation.

2.2 Fixed and varied elements as deep and surface structures

In the common-practice theme and variation tradition, when composing a variation, the composer would choose which elements of the theme to stay fixed and which elements to be varied. In the beginning of such a piece, when the variations are relative simple compared to those near the climatic points of the piece, the fixed elements are usually related to deep structure, for example the underlying melodic and harmonic structure of the theme, while the varied elements are related to surface structure, for example the rhythmic and melodic configuration of a theme and the precise harmonic sequence (Figure 2-1). As a piece develops, the kinds of variations carried out would also progress from being variations on the surface structure to variations on the deep structure in order to project a sense of progression that pushes the piece through a macro-level trajectory of tension and relaxation.

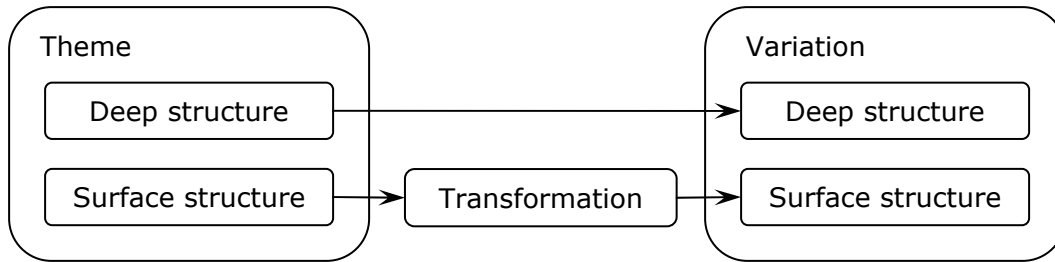


Figure 2-1: Deep and surface structure illustrated as the fixed and varied elements in a theme and variation

2.3 Cross-cultural analogy as variation on deep structures

In the experimentations of cross-cultural variation, when a theme from one culture is stripped down to its deep structure, it can not be directly used as a skeleton for elaboration in another culture, since the shared musical language between the cultures is limited. Hence, we must find cross-cultural analogies at the level of deep structures. Although in an analogy we are seeking for the closest parallel, the musical systems of each culture are sufficiently different, the listeners would perceive such a mapping as a kind of variation, and depending on a composer's perspective, there can be many possible kinds of such matches. In making such a decision, a composer is concerned with the same questions being asked in the common-practice theme and variation tradition, but simultaneously at many structural levels with two main concerns.

First, what is the fixed element at the level of deep structure? If the fixed element in a common-practice theme and variation is already the deep structure, then the fixed element at the level of deep structure would be the deep structure of the deep structure, which I call the hyper-deep structure. This hyper-deep structure is preserved in a cross-cultural variation to carry the genetics of its parent cultural style, while the other deep structures are left to mutate (Figure 2-2).

Second, once the fixed element is decided upon, what do the other elements map onto in another cultural style? These remaining elements at the level of deep structure are varied through cross-cultural analogy. To decide what the corresponding deep structure is in another culture, both the deep structure and the surface structure needs to be considered simultaneously, since this transformed deep structure will serve as the foundation for the deep-to-surface-structure elaborations and influence the potential for creating aural similarities between the surface structures of the two cultures.

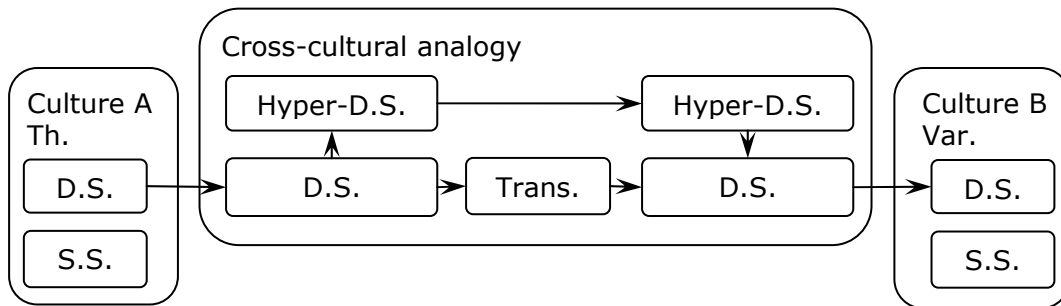


Figure 2-2: Cross-cultural analogy as variation at the level of deep structure.

2.4 Forward and backward cross-cultural transformation

In order to further articulate the second concern above, I first define two concepts, namely forward cross-cultural transformation (Forward CCT) and backward cross-cultural transformation (Backward CCT), and then discuss them with respect to the above mentioned levels of structure.

When we transform a melody from culture A to culture B, for example, to create a variation of A in culture B, then forward cross-cultural transformation is defined as transforming some element of the melody in culture A to be more similar to that in culture B, and a backward cross-cultural transformation is defined as transforming the some element of variation of A in B to be more similar to that in culture A. Normally, the backward cross-cultural transformation would be preceded by the forward cross-cultural transformation in order for the former process to have a variant melody to proceed with. Cognitively, the order of presentation is critical for the listeners when deciding which melody is the variation and which is the original theme. For example, if we hear a certain melody first, and then listen to a similar second melody immediately after, the second melody would be heard in the context of the first and be compared to it, and naturally be thought of as the variant, unless we had prior knowledge that the second melody existed first or if we were more familiar to the second melody. However, most important in a cross-cultural context, in addition to establishing the relationship between a theme and its variation, is the cultural identity of variations. This is dependent on the elements we choose to transform in order for a variation to serve dual identities.

2.5 Possible interpretations on a “variation”

The concept of cross-cultural transformation is to start with a melody composed in culture A and through transformations at different structural levels create a melody in the style of culture B that is perceived as both a melody that posses the identity of culture B but is related to culture A to the

degree of variation. This requires the transformed melody to possess characteristics from both of the cultures. However, these characteristics may compete with each other to raise questions such as, given a theme from culture A, is the variation in the cultural style of culture A or B? Is the "variation" related to the theme in form of a variation? Table 2-1 below lists some of the possible combinations of characteristics possessed by a variation, in a very coarse scale of true (T) or false (F), as relevant to the discussion above. The goal of cross-cultural transformation is to achieve case 4, where the variation is considered as both with a cultural stylistic identity of B and a variation of the theme with a cultural stylistic identity of A, but the variation itself is not perceived to have a strong cultural stylistic identity of A.

Table 2-1: The possible interpretations of the combinations of characteristics possessed by a variation.

Characteristics\ Case	Cultural style A	Cultural style B	Variation of theme in A
1	T	F	F
2	T	F	T
3	F	T	F
4	F	T	T

2.6 Fusion versus cross-cultural variation

In Table 2-1 above, there could also be cases where the identities of cultural styles A and B are not mutually exclusive. In other words, a single melody can be considered as simultaneously in the musical style of culture A and B, as a kind of fusion, a kind of hyper-style or hybrid style. In fact, case 4 also implies a certain degree of fusion. Since when a melody is perceived as a variation of a theme in a certain culture, it must also possess certain characteristics from that cultural style, making the concepts of identity "in the cultural style of A" and "variation to a theme in the cultural style of A" non-orthogonal.

When there is more than one voice in a piece, each part can easily carry its own cultural stylistic character and adapt to each other to create fusion. However, when a piece is in monophony without rhythmic accompaniment, fusion may become the case of "neither nor", where there are two "false" in the columns for cultural style A and B. Thus, in order to be associated with a cultural style, a melody needs to sufficiently carry a style's characteristics. If we treat two cultural styles as being at the two ends of a spectrum, being close to one cultural style means that we are far from the other, with fusion

being somewhere in the middle. Thus, in a cross-cultural transformation, fusion can be interpreted as the intermediate station to establishing a variation's cultural stylistic identity.

However, the location of a threshold for establishing a melody's cultural identity can be ambiguous, as it is dependent on interpretation and the degree of dissimilarity between two cultural styles. This threshold may be very close to one end, or somewhere not too far from the middle. This may cause the result of fusion and cross-cultural transformation to be very similar. What distinguishes them from each other is the fundamental approach and ideal of the artistic exploration. Cross-cultural transformation is based upon the spirit of theme and variations and therefore emphasizes the processes involved in variations. Cross-cultural variation explores the fixed and variable elements of a theme in a multi-level structural fashion, with the goal of finding an expression in another culture that expands the creative potential of the original expression across cultural boundaries.

2.7 The process of cross-cultural transformation

The goal of cross-cultural transformation is of course case 4, as defined in Table 2-1 from above, in which through cross-cultural variation, a variation is generated in a cultural style other than that of the theme, but relates to the theme through variation.

This goal is approximated by the process of first performing a forward cross-cultural transformation in mapping cross-cultural analogies at the level of deep structure and then a backward cross-cultural transformation on the surface structure for adapting the surface structure of culture A on to that of culture B to increase the perceived resemblance between the two melodies (Figure 2-3).

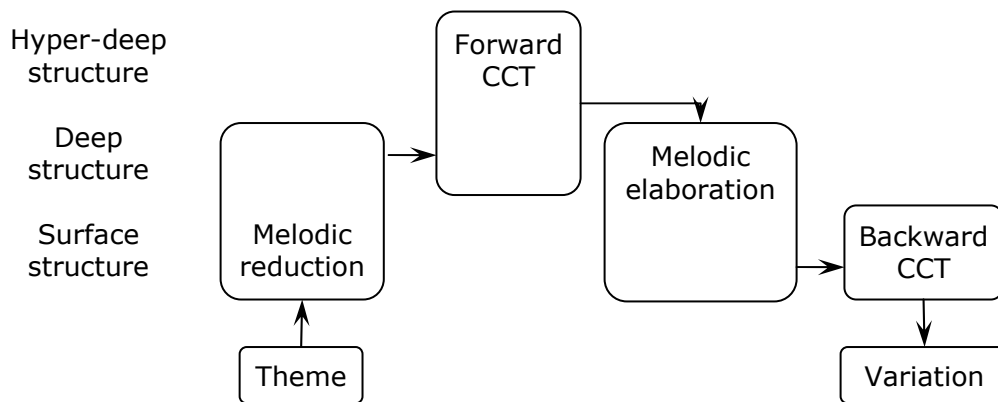


Figure 2-3: The flowchart for the processes involved in a cross-cultural transformation.

Hence, the transformed melody would have the hyper-deep structure of culture A, the deep structure of culture B which is an analogy to that of culture A and both the surface structure of A and B (Figure 2-4). The deep and surface structure establishes the cultural stylistic identity of a melody. The deep structure creates a cross-cultural variation of A in B, while the hyper-deep structure and the surface structure glues the theme and variation together so that they are perceived as related instead of two separate entities.

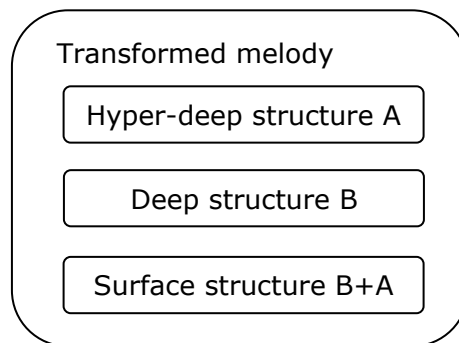


Figure 2-4: The structural components of a variation after the process of CCT.

2.8 Cross-cultural transformation stretches the limit of variation

Cross-cultural variation stretches the definition of common-practice theme and variations with regard to the relationship between a theme and its variations. Green (1979) defines common-practice theme and variations as varied repetitions. Green further explains this definition by contrasting the concept of varied repetition to similarity. A variation is a varied repetition of a theme when the cadence is preserved, whereas two musical segments are only considered similar if the cadence is varied, not varied repetition even if there were high degrees of similarity along the other musical dimensions. Hence, in a theme and variation, at least in the beginning variations, the cadences of the basic progression must be maintained in order to project a sense of coherence in terms of degrees of conclusiveness.

However, in cross-cultural variations, the exact cadences of a theme are not carried over. Instead, it is varied with analogical cadences from other cultural styles. While stretching this fundamental limit, cross-cultural variation compensates the cognitive distance through backward-cross-cultural transformation. This transformation attempts to reinforce coherence through surface filtering, which is less-intrusive than varying the underlying structure but gives the illusion of resemblance.

With regard to the sequential order of varying the different levels of structure, cross-cultural variation is a kind of reversed variation, as it first varies the deep structure. As a piece progresses, it decreases the amount of backward cross-cultural transformation on the surface, while common-practice variations first vary the surface structure, and then later proceed towards varying the deep structures.

2.9 Levels of structure

In the context of cross-cultural variation, I have introduced three major conceptual levels of structures, surface, deep and hyper-deep with respect to the fixed and varied elements of a theme. Before mapping these conceptual levels of structures to concrete musical structures, I first clarify the relationship between my definitions of the terms "deep structure" and "surface structure" and that in common usage.

Perhaps the most common immediate association to deep and surface structure is to that described in Chomsky's (1957) "transformational generative grammar". In his "Syntactic Structures", Chomsky proposed that each sentence in a language has two levels of representation, namely a deep structure and a surface structure (Wiki). The theory can be broadly understood as the "deep structure" representing the core semantic relation of a sentence, and the "surface structure" that adheres to phonological form of a sentence. "Deep structure" can be mapped on the "surface structure" via transformations.

In this thesis, I align the phonological constituent "surface structure" in linguistics to the melodic and rhythmic structure of the playing techniques and local elaborations. Informed by the local groupings, melodic reductions can be carried out by extracting the structural melodic events and in the process learn a grammar for elaborating a melodic skeleton into a full-blown melody. However, such a process is reasonably reversible only if sufficient context, along with motivic and thematic dependencies are captured. A succession of structural melodic events, as the one extracted above, is called the melodic progression. With a melodic progression, a melodic syntax can be induced by analyzing the patterns of transitional paths between the pitch attributes of the individual structural melodic events to reveal the syntactical function of each of the pitch classes present.

Melodic formulae are induced by extracting characteristic melodic progressions, with reference to their positions in a phrase and a particular section of a piece. These melodic formulae are aligned to the semantic relational "deep structure" in linguistics. Here, semantic relations come into music with a twist to represent the meaning and tension that emerges as the structural melodic events join to form a melodic formula, assuming the audience is familiar with the stylistic idioms. The most obvious melodic formula is a cadence, which gives a conclusive effect and is positioned at the

end of phrases and sections, possibly also in the beginnings depending on the cultural style studied. Different cadential formulae can induce different degrees and types of conclusiveness, which are reinforced by certain surface structures through melodic elaboration. In the context of this thesis, tension is a function of the nature of a melodic formula, including its contour and its underlying melodic progression and the degree and kinds of embellishment involved. Cross-cultural mappings can be experimented at the level of deep structure by searching for melodic formulae across cultural styles that are analogical by function and tension. If a sub-phrase is the unit for melodic formulae, then the "hyper-deep structure" would be the melodic formulae of the melodic formulae at the unit/grouping of a phrase, capturing yet a longer-range of relations, which imply patterns of tension that gives a certain sense of aesthetics and affect.

The Table 2-2 below shows the raw input melodic sequences to each structural level on which structure is induced and the corresponding grammars learned which characterize the local melodic gestures on that level. In the melodic reduction process, context-sensitive grammar is used to capture how structural melodic events in a certain context can be extracted from local melodic patterns. The resultant reduced melodic sequence is then fed into the next deeper level of structure as a raw input. Each raw input is described by its cognitive role on the melodic surface. For example, when we hear a full-blown melody embellished with all the playing techniques, the foreground is the sequence of notes that we hear. However, not every note is as important as its surrounding notes, and as we learn a stylistic idiom, we group these local elaborations and extract the more structural tones which form a melodic sequence in the middle ground of our perception as the context for the foreground materials.

Table 2-2: Levels of structure and its raw inputs.

Function on melodic surface	Input from previous level	Level of structure	Grammar Induced
Foreground	Seq. of note events	Surface	Playing techniques
	w/o certain playing techniques		Other embellishments & local elaborations
Middle ground	Melodic reductions at various durational levels, i.e. 8 th -note	Deep	Variational melodic formulae
	2 nd level, quarter-note		Abstract melodic formulae
	3 rd level, "half-note"		
Background	Seq. of melodic formulae	Hyper-deep	Formulae of melodic formulae

CHAPTER 3

Melodic Reduction

Cross-cultural music transformation can be approached as a kind of cross-cultural variation. The previous chapter introduced four core processes involved in cross-cultural variation, namely melodic reduction, forward cross-cultural transformation, melodic elaboration and backward cross-cultural transformation, which transverses three major levels of structure, that being the surface, deep and hyper-deep structures. This chapter focuses on the process of melodic reduction which connects the surface structure to its underlying deep structure which figurates in the background of a listener's listening experience.

This chapter is outlined as follows. First, the concept and overall process of melodic reduction is described. Second, as melodic reduction requires culture-specific and style-specific knowledge, the modal systems of the Chinese and Japanese musical systems are briefly introduced. Third, the grouping and meter structures are interpreted in the context of instrument-specific idioms. Fourth, melodic reduction is demonstrated through hierarchical time-span reduction. Finally, the underlying melodic progression is analyzed to reveal the melodic formulae.

3.1 The concept of melodic reduction

When we hear a melody, not only do we hear an evolving spectrum of sound waves or a sequence of events, but we constantly organize and re-organize them into musical structures and we hear every aspect of sound in the context of these mental models. Fred Lerdahl and Ray Jackendoff (1983) address this process in their *Generative Theory of Tonal Music (GTTM)* by proposing a set of principles that simulate how listeners familiar with the western classical tonal idiom would arrive at the underlying hierarchical musical structures of a piece (2001). These principles build upon the Schenkerian concept of inducing hierarchical relationships among pitches in a piece through reduction and prolongational techniques. Figure 3-1 schematizes the overall process of structure induction.

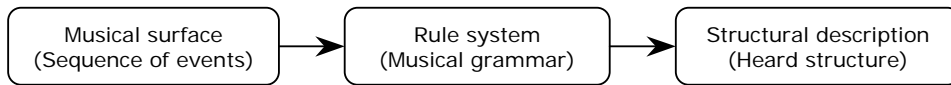


Figure 3-1: This schematic illustrates the overall process of structure induction, extracted from (Lerdahl & Jackendoff, 2001).

In the scope of this thesis, a musical surface is treated as the sequence of note events in the notated score of a monophonic composition. This sequence of note events takes the “foreground” in a listening experience, while the structure induced by the listener’s figurates in the “background” and carries the deep structures. The melodic reduction process approximates the cognitive process of listening and structure induction. It takes the musical surface in the foreground as its input, and performs a rule-based reasoning of the relative structural importance of the note events, revealing the underlying melodic progression hidden in the background. The next section describes the sub-processes involved in this reasoning process by first introducing the sub-processes proposed by Lerdahl and Jackendoff (1983) to model how listeners organize the musical surface into coherent structures.

3.1.1 The process of melodic reduction

The process of melodic reduction approximates how a listener cognitively constructs musical structures from the musical surface of a piece. In the Generative Theory of Tonal Music (GTTM), Lerdahl and Jackendoff (1983) proposed five kinds of hierarchical processes, namely grouping, meter induction, time-span segmentation, time-span reduction and prolongational reduction. The reduction processes in the last two processes, time-span reduction and prolongational reduction, are dependent on the general trends of pitch stability in the tonal system rather than the event structures in a specific piece (Lerdahl & Jackendoff, 2001). The above relationships are illustrated in Figure 3-2.

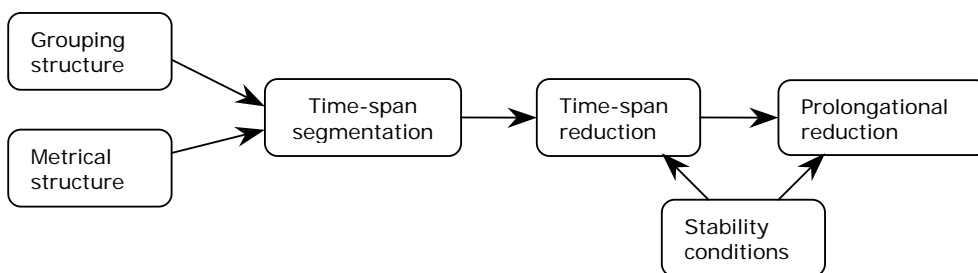


Figure 3-2: A flowchart of the processes and hierarchies that take part in the process of structure induction, extracted from (Lerdahl & Jackendoff, 2001).

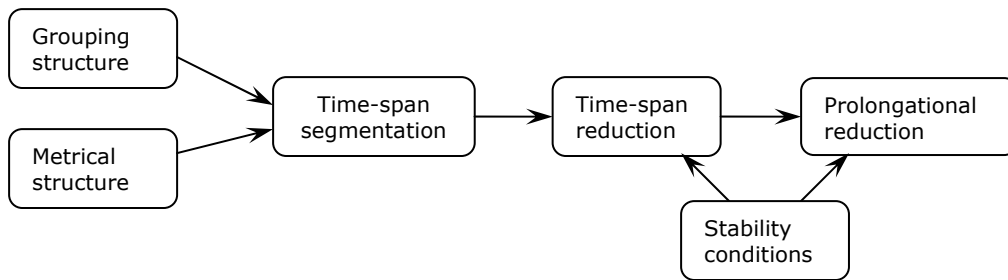


Figure 3-2: A flowchart of the processes and hierarchies that take part in the process of structure induction, extracted from (Lerdahl & Jackendoff, 2001).

The grouping process captures how a listener segments the musical surface into units such as motives, phrases, and sections, while the process of meter induction gives rise to a perceived hierarchy of strong and weak beats. The grouping and meter structures are then fed into an intermediate process of time-span segmentation, which determines the grouping of note events at all metrical subdivision levels. From the smallest time-span which is the length of time of the shortest durational value, the note events are grouped according to the metric hierarchy. When the time-span reaches a metrical subdivision level on which the “motivic grouping” and the “metrical grouping” do not coincide, the “motivic grouping” dominates. These resultant nested hierarchies of segments are fed into the time-span reduction process which is the primary process that links the rhythmic dimension to the dimension of pitch in a piece. Time-span reduction establishes the relative structural importance of events within every time-span unit. Upon finalizing the dominating-subordinating hierarchy of events produced by process of time-span reduction, the prolongational reduction process is evoked to determine the perceived patterns of tension and relaxation.

The process of melodic reduction models GTTM up to the process of time-span reduction. In the following sections, I will demonstrate how culturally-specific and stylistically-specific knowledge is incorporated into each of the sub-processes to approximate a listener’s familiarity to a specific cultural style.

3.2 Modal system

In order to uncover the deep structure of a cultural style, we first study its modal system to understand the underlying mechanisms of organization that govern the musical surface. The modal system of a culture is characterized by its scales, the scale-degree hierarchy associated to each scale, the melodic and cadential formulae encouraged by the specific configuration of each scale, the scale degree used to end a piece, the usage of ornamental scale-degrees, and in some cases the extra-musical associations (Powers et al, 2008). This section focuses on uncovering the scale and its associated scale-degree hierarchy by performing a case study on the Japanese koto piece *Rokudan* and the Chinese gu-zheng piece *Chu Shui Lian*. The melodic and cadential

formulae will be analyzed later in section 4.1 when we have learned how to perform melodic reduction in the context of these two cultural styles.

First, a simple statistical analysis is performed to obtain the pitch-class distribution. The tonic of a scale is identified if the pitch class that concludes a piece is also the pitch class that is most frequently heard. Second, by inspection the pitch classes are grouped into three tiers according to their proportion of "airtime" in the pitch-class distribution. Third, the three-tier system and the tonic if determined are interpreted as the pitch-stability hierarchy. The pitch-stability hierarchy will later be used to approximate the "stability conditions" used in time-span reduction. The pitch-stability hierarchy also provides a sketch for the scale-degree hierarchy. Fourth, the concept of melodic attraction is introduced, and the pitch-stability hierarchy is used to lay out a pitch space for calculating the degree of melodic attraction between pitch classes in the bottom two tiers and the pitch classes in the top tier. Fifth, along with the pitch-class transition distribution matrix, the melodic functions of the pitch classes in the bottom two tiers are analyzed. This concludes the sketch of the scale-degree hierarchy as the pitch classes in the top tier are now known to be different kinds of structural reference points for each of the pitch classes in the bottom two tiers.

In a cross-cultural context, we refer to a piece as being in a specific cultural style where the adjective "cultural" is used to specify the particular musical system of a culture, while the noun "style" is used to specify the basic musical language realized within that musical system.

3.2.1 The concept of a musical scale

If we were given a melody composed in an unfamiliar cultural stylistic idiom, what could we do to identify the underlying structures that govern the melodic organization of pitches? One could first start by examining one of the most basic properties of a musical system, i.e. the collection of sounding pitches in a melody. The concept of scale provides a natural point of departure for organizing these pitches.

A scale arranges all the principle sounding pitch classes in ascending order according to pitch height. If pitches are inflected or substituted by other pitches during descents, a descending iteration of pitch classes is also included. A scale may encompass more than an octave if the collection of sounding pitch classes varies at different octaves. However, this is by no means a trivial task since a scale does not only represent a collection of pitches, but implies a hierarchy of pitch classes with respect to pitch stability.

An introduction to the pitch-stability hierarchy

This pitch-stability hierarchy related to a scale consists of three major levels, with the top level hosting the most stable pitch class, which is the pitch class chosen to be the starting tone of a scale, often referred to as the

tonic. The choice of this starting tone also determines the intervallic relationships between the scale degrees. Not all sounding pitches are included in the scale. The middle level consists of all the pitch classes other than the tonic, while the bottom level consists of all the sounding pitches that were not offered membership to the scale. There are three categories of pitches that fall into this bottom level. The first category consists of the "chromatic" pitch classes that appear when a piece temporarily tonicizes other scale-degrees. Both the second and third category consists of "neighboring" pitches that are introduced in performance through embellishing gestures, but are further distinguished from each other by the determinability of their sounding pitches. For example, the third category would include the pitches introduced through gestures such as glissando and portamento where pitches are not meant to be clearly established. In such gestures, we do not hear a discrete sequence of pitches with definite pitch-height boundaries. Instead we hear a continuous slide through a range of pitch heights.

Hence, before we can begin building a scale, we must first determine a finite set of sounding pitch classes that should be considered for membership. In addition to the continuous gestures mentioned above that introduce infinite sets of sounding pitches, the pitch classes that are articulated are often played with varying amounts of inflection in response to particular musical contexts. Therefore, if we were unfamiliar with the cultural style in which the melody was composed, we would have to first cluster all the articulated tones according to pitch height and then determine a representative pitch class for each cluster. However, once we do have a finite set of representative pitch classes, how do we determine which pitch class in a melody belongs to which one of these three major levels in the pitch-stability hierarchy? In other words, given a collection of pitch classes, how do we build its scale? For now, assuming the transcribed score is also available, I will address these concerns partially by presenting a simple statistical analysis of how frequently each pitch class is heard in a melody.

3.2.2 Learning pitch-stability hierarchy from a Japanese score

In order to uncover the scale used by a melody, I first determine the collection of pitch classes used to compose this melody. I start with one of the most popular solo koto pieces in the *Danmano* repertoire, titled *Rokudan*. The piece is transposed down a major 3rd for ease of comparison. Figure 3-3 shows a simple histogram of all the sounding pitch classes and how frequently each pitch class is heard in the piece. The y-axis shows the percentage of "air-time" each pitch-class receives. In other words, for each pitch class, the duration of all of its occurrences are summed and the y-axis represents this summed duration as a percentage of the total length of the piece.

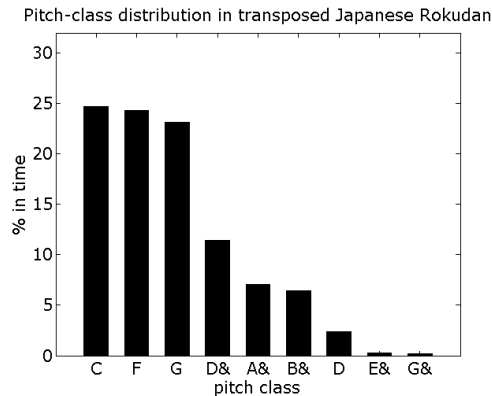


Figure 3-3: The pitch distribution of Japanese *Rokudan* transposed down a major third.

An introduction to a tier system based on pitch distribution

By inspection, the pitch classes in Figure 3-3 can be roughly divided into three tiers, according to the percentage of time they are heard in a piece. The top tier consists of the pitch classes that are most frequently heard. Table 3-1 shows which pitch class belongs to which tier, along with their relationship with the scale which is further elaborated below. A scale only explicitly shows the tonic of a piece, by starting on that pitch class when arranging all the pitch classes into an ascending order. The importance of the rest of the scale degrees is only implied through their configuration on the scale. The introduction of the statistically based tier system further reveals how important each scale degree is according to its airtime. In the tier system, I assume that the pitch stability of each pitch class is correlated with how frequently it is heard. For example, the pitch classes belonging to the top tier are considered to be the most stable. Therefore, if we are looking for candidates for the tonic position, we would only consider the pitch classes in the top tier. However in the current piece, the three pitch classes in the top tier are in too close to call. Hence, in addition to occurrence frequency, we also have to consider other musical properties possessed by a pitch class. If the cadence that concludes a piece is considered the most predominant factor in determining the tonic, then pitch class C will be interpreted as the tonic as it is the final note in the last cadence, while pitch class F serves as the penultimate tone and pitch class G initiates the cadence. This interpretation is used in Table 3-1 to assign all the pitch classes to their relative scale degrees with respect to pitch class C being the tonic. Furthermore, when constructing the scale, only the pitch classes from the top two tiers are included. The bottom tier consists of pitch classes that are too infrequently heard to be offered membership to the scale. They are mostly called for in local embellishments or temporary tonicizations of other scale degrees.

Table 3-1: The scale and tier levels of all the pitch classes in transposed *Rokudan*.

Scale levels (scale configuration)	Tier levels (pitch distribution)	Pitch classes	Scale degree
Tonic	Top	C	I
Included in scale		F, G	IV, V
	middle	Db, Ab, Bb	II, VI, bVII
Not included in scale	bottom	D, Eb, Gb	#II, bIII, bV

The tonic above was determined by first considering the proportional occurrence frequency of a pitch class, and then its position in the final cadence, which implies its function in the cadence. This interpretation can be checked against culture-specific knowledge. According to Japanese music theory, the *in* scale characterizes a significant proportion of Japanese traditional music since the 16th century (Powers et al). To construct an *in* scale, the octave is divided into two 4ths. This scale has to be shown with both its ascent and descent, as their configuration differs in further subdivisions. While the lower 4th in the ascent and the two 4ths in the descent are further divided into a semitone and a major 3rd, to provide an upper leading tone to strengthen the cadence to the fifth and the tonic, the upper 4th of the ascent is instead divided into a minor 3rd and a major 2nd. Hence in an ascent, there is no leading tone to the fifth scale degree and the tonic. This prevents the formulation of a strong cadence that relaxes the melodic line and helps to garner sufficient momentum in an ascent to push the melodic line upwards beyond the fifth towards the upper tonic and further beyond. It will be shown later in section 4.1 that the melodic formulae employed in *Rokudan* are related to these divisions of the scale. Figure 3-4 shows three groups of scales to illustrate the relationships between theory, practice and the tuning of instruments. The original tonic of both the *in* scale and the scale employed by *Rokudan*, and the first string of the koto are all E, while in this study all are transposed to C for ease of cross-cultural comparisons, and immediate pitch-class and scale degree association, as C will predominately be the tonic, the first scale degree. The transposed *Rokudan* scale shows a raw arrangement of all the pitch classes from the top two tiers into an ascending order, with C as the bottom note. After being informed by the configuration of the *in* scale and by the melodic formulae in *Rokudan*, the raw hexatonic scale built for *Rokudan* can indeed be reorganized into an ascent and descent of pentatonic scales that is identical to that of the *in* scale. Moreover, the pitch class C is the only possibility among the pitch classes in the top tier to be the tonic in order to maintain the two nested levels of divisions described above. Furthermore, the scale degrees in Table 3-1 were assigned according to the configuration of the *in* scale. For example, pitch class Db is interpreted as II instead of bII, even though it is only one "semitone" higher than C instead of two. However, when a scale degree does not explicitly appear in the *in* scale, Roman numerals are

assigned to reflect the intervallic distances associated to the western scales. For example, pitch class Eb is assigned the Roman numeral bIII instead of III because the intervallic distance from F to Eb is two "semitones", even though Eb is also two "semitones" away from II.

Figure 3-4: The in scales, the raw *Rokudan* scale and the "koto scales".

The "koto scale" presented above in Figure 3-4 is an octave extracted from the *hira-joshi* tuning of the koto that is most representative of the *in* scale. The above "koto scale" shows that the koto strings are tuned to the five most frequently used pitch classes. This covers all the pitch classes in the top two tiers, except pitch class Bb, which is the least frequently used pitch class among all the pitch classes in the top two tiers. Hence in ascending patterns that call for the Bb, it will be played as a pitch bend which is achieved through left-hand playing techniques by adding pressure to the string that is tuned closest to Bb but lower. This increases the tension of the string and when carefully controlled, the tone of the string can be raised to that of Bb.

A brief discussion on the tuning of the koto

The tier system also helps us to understand the tuning process of the koto. As described by Adriaansz (1973), the basic tones of the scale, namely the first, fourth and fifth scale degree, which constitutes the top level of the tier system, is tuned first to provide reference points for the other tones. The fourths and fifths created between the tonic and the fourth and fifth scale degrees are not tempered but perfect, creating just intervals of 4:3 and 3:2, which are respectively slightly lower and higher than the tempered fourths and fifths. The tunings of these three tones, which constitutes nine of the thirteen strings on the koto, are the same no matter which musician tunes the instrument. However, the remaining strings tuned to the second and sixth scale degree in the middle tier vary among musicians. In abstraction,

these two pitch classes form a “half-step” with the tonic and the fifth scale degree, but in practice they can be up to 15 cents lower than that in equal temperament (Adriaansz, 1973, p.40). However, there has been “a tendency nowadays to tune the koto to the western tempered scale” (Adriaansz, 1973, p.40). For a more detailed explanation on the relationship between the Japanese scales, the step-by-step tuning procedure of the koto and the specific measurements of tunings among performers with different backgrounds, see Adriaansz’s *The Kumiuta and Danmono Traditions of Japanese Koto Music*.

Revisiting and expanding the pitch-stability hierarchy

Earlier in the discussion on scale induction, I introduced three pitch-stability levels that are directly related to the configuration of a scale. With assistance from the tier system, the pitch-stability hierarchy can be further expanded into four hierarchical levels. From the top to the bottom, the levels are the tonic which is the most stable pitch class, and then the “skeletal tones” which are the basic pitch classes that outline the structure of a piece, and then all the pitch classes that constitute the scale, and finally all the identifiable sounding pitch-classes that are employed in a piece. Table 3-2 outlines the pitch-stability hierarchy along with the pitch classes that constitute each hierarchical level.

Table 3-2: Pitch-stability hierarchy of transposed *Rokudan*.

Pitch-stability hierarchy\Scale degrees	I	II	#II	bIII	IV	bV	V	VI	bVII	I
The tonic	C									C
The skeletal tones	C				F		G			C
Pitch classes in the scale	C	Db			F		G	Ab	Bb	C
All principle sounding pitches	C	Db	D	Eb	F	Gb	G	Ab	Bb	C

From pitch stability to melodic attraction

The layout of pitch classes in Table 3-2 is inspired by how Lerdahl lays out a basic pitch space in his explanation of melodic attraction, as illustrated in Figure 3-5. While I use Table 3-2 to give the frequentist-based pitch-stability hierarchy in the context of a specific piece, Lerdahl uses Figure 3-5 to approach pitch stability from another perspective, by considering “anchoring strength” in the context of a basic pitch space that is oriented to a specific chord in a particular key, in this case the harmonic context is the triadic C chord, which is the tonic chord of C major. The basic pitch space consists of four levels. From the top level to the bottom level, the pitches that constitute the levels correspond to the tonic, the chordal, the diatonic and the chromatic pitches. The pitches on the chordal level explicitly capture the specific chord that

represents the harmonic context of the pitch space. As shown on the left-hand side of Figure 3-5, anchoring strengths are assigned to pitches by the level it occupies in the basic pitch space, in a descending fashion. Therefore, the higher a pitch is on the levels, the stronger anchoring strength it possesses. This definition of “anchoring strength” resonates with our intuition of how chromatic and diatonic dissonances on the melodic surface tend to resolve to consonant neighbors, which correspond to pitches on higher levels, such as the chordal or tonic level. Anchoring strength is one of the defining factors in melodic attraction.

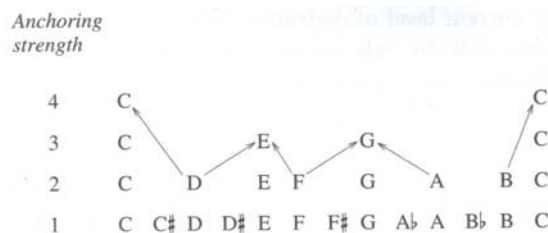


Figure 3-5: This figure, extracted from Lerdahl’s *Tonal pitch space*, shows “the basic pitch space oriented to I/C”, “with anchoring strength indicated by level” and neighboring attractions shown by arrows (Lerdahl, 2001, p.162).

Lerdahl (2001) quantitatively models melodic attraction from pitch p_1 and pitch p_2 in the above context as a product of the ratio of the anchoring strengths of p_1 to p_2 and the inverse of the square of the number of semitones between p_1 and p_2 . The first operand captures the relative stability of the two pitches, while the second operand embodies the notion of proximity. The formula is given as follows:

“Melodic attraction $a(p_1 \rightarrow p_2) = s_2 / s_1 \times 1/n^2$, where p_1 and p_2 are pitches, with $p_1 \neq p_2$; $a(p_1 \rightarrow p_2)$ = the attraction of p_1 to p_2 ; s_1 = the anchoring strength of p_1 and s_2 = the anchoring strength of p_2 in the current configuration of the basic space; and n = the number of semitone intervals between p_1 and p_2 . (The stipulation $p_1 \neq p_2$ avoids a denominator of 0)” (Lerdahl, 2001, p.163).

According to the formula described above that quantifies melodic attraction, pitches are most strongly attracted to their superordinate neighbor, since they are at least one anchoring-strength level apart and are in proximity to each other. A superordinate neighbor of a pitch p_1 is defined as a pitch that is adjacent to p_1 on its level and also present at the hierarchical level just above that of p_1 . In Figure 3-5, attractions of diatonic pitches to their triadic neighbors are shown by arrows. These melodic attractions all have an attraction value of 0.375 or higher, which means that the two pitches are at least one anchoring-strength level apart and at most two semitones apart. I define these attractions as strong melodic attractions. For a complete definition and detailed quantitative analysis of melodic attraction and its cognitive implications, see the “Melodic tension” section in Lerdahl’s *Tonal Pitch Space*.

Although Lerdahl's model of melodic attraction was discussed in a local harmonic context, it can be reasonably generalized for application in the frequentist-based melodic context of an entire piece, as the hierarchical levels in the two are highly similar, although the scopes are different. For example, in Table 3-2, pitch class C can be interpreted as the superordinate neighbor of pitch class Db. Db is strongly attracted to C because C is two pitch-stability levels higher than Db and only one "semitone" away. Similarly, pitch class Db has a subordinate neighbor D that is strongly attracted by it. By inspection, all the strong melodic attractions are summarized as follows, with the first scale degree attracted towards the second scale degree: II→I, #II→II, bIII→IV, bV→IV or V, VI→V, bVII→I. The plausibility of these melodic attractions can be partially checked via a simple statistical analysis of how frequently these melodic attractions are realized as actual pitch-class transitions.

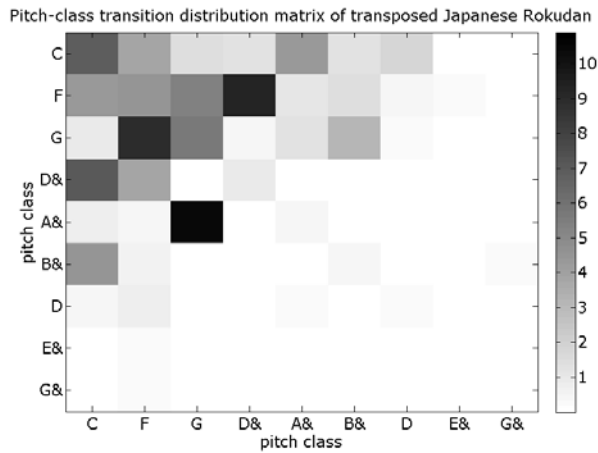


Figure 3-6: Pitch-class transition distribution matrix of transposed Japanese *Rokudan*.

Figure 3-6 shows the pitch-class transition distribution matrix of the transposed Japanese *Rokudan*. Each row in the matrix captures how frequently a pitch class transitions to itself and to all the other pitch classes, with respect to all the pitch-class transitions in the piece. For example, the cell in the first row, second column shows how frequently pitch class C transitions to pitch class F in the piece by representing the summed duration of all the Fs that follow C as a percentage of the total length of the piece. Pitch-class transitions are not captured as mere counts, but are captured through duration based on the assumption that a transition to a note with a longer duration is a transition that is perceptually more prominent and hence implies a stronger melodic attraction. In Figure 3-6, the darker a cell, the more frequent a transition is called to attention.

Four of the six strong melodic attractions proposed above by generalizing Lerdahl's metric are realized as the most frequently pursued pitch transitions in *Rokudan*, as illustrated in Figure 3-6 by the darkest cell in a the row that

corresponds to the pitch class that initiates the transition. These strong melodic attractions are II→I, bIII→IV, VI→V and bVII→I. Scale degrees bIII and bVII can be interpreted as the lower neighbors of scale degrees IV and I respectively, where each attraction pair is two "semitones" apart. Scale degrees II and VI are treated as upper leading tones to pitch class I and V respectively and are each a "semitone" above their goals. Scale degrees II and VI are two of the scale degrees included in the tuning of the koto. This helps to explain why these two strings are traditionally tuned much lower than their equal-tempered correspondences, musicians tend to tune "unstable" pitches closer to their "resolutions" than the other scale degrees to enhance the need for resolution (Lerdahl, 2001). In Lerdahl's attraction model, this tuning adjustment also increases a scale degree's attraction to its resolution as the distance between them is decreased.

The ambiguity in the melodic attraction bV→IV or V is resolved to bV→IV as scale degree bV is most frequently called for in a descent to act as the upper leading tone to IV, in order to strengthen the fourth scale degree's structural importance in these gestures. This functionality is reflected in the scale degrees bV's pitch spelling. The only melodic attraction not realized in *Rokudan* is #II→II. Instead, the scale degrees that most frequently follow scale degree #II are IV and I, although according to the melodic attraction formula described above, the attraction of scale degree #II to II is $2/1 \times 1 = 2$ is higher than that to IV which is $3/1 \times 1/9 = 0.33$ and I which is $4/1 \times 1/4 = 1$. However, these attraction quantities are calculated in the pitch space of the entire piece, and do not reflect the local melodic context. When the second scale degree is sharpened, it substitutes the original uninflected second scale degree to emphasize the fifth scale degree instead of the tonic. In other words, the sharpened second degree serves as a secondary dominant to temporarily tonicize a local fifth scale degree. Hence, in a local pitch space, the #II scale degree would be elevated to the diatonic level, and its superordinate neighbors would be scale degree I and IV instead of one. Although the melodic attraction of #II to I is higher than that to IV, IV follows #II more frequently than I. Local melodic attractions are not direct hints for melodic predictions, as composers and listeners may prefer lower attraction states in order to fulfill their expectations of familiar style-specific patterns that do not realize the highest attracted transitions. In order to account for these cultural preferences, we have to look beyond a first-order musical context, which would be further explored in future work.

According to the current zero and first-order analysis of *Rokudan*, the melodic functions of the scale degrees in the bottom two tiers are presented in Table 3-3. The melodic functions are defined by how a scale degree embellishes another scale degree from the top tier to strengthen the latter scale degree's structural importance locally. This does not account for a scale degree's melodic function in a melodic pattern. For example, VI is locally considered to be the upper leading tone of V, but in the context of an idiomatic melodic pattern such as I – VI – V, VI is considered a "passing" tone.

Hence, the melodic function of a scale degree depends on the level of analysis being pursued.

Table 3-3: The first-order melodic function of pitch classes in the bottom two tiers.

Scale degree	1st-order melodic function	
	Kind of embellishment to	scale degree
II	Upper leading tone to	I
bVII	Lower neighboring tone to	I
#II	Upper, lower neighboring tone to	I, IV
bIII	Lower neighboring tone to	IV
bV	Upper leading tone to	IV
VI	Upper leading tone to	V

3.2.3 Learning pitch-stability hierarchy from a Chinese score

Similarly, one of the most popular solo gu-zheng pieces titled *Chu sui lian*, which literally translates to “Blossoming Water Lillies” (Thrasher, 1989), is analyzed with respect to its pitch-class distribution and first-order pitch-class transition distribution in order to learn its pitch-stability hierarchy. Consequently, the pitch-stability hierarchy allows us to setup a pitch space for analyzing the melodic attractions between scale degrees. However, the modality of this piece is not as clearly defined as the *Rokudan* piece analyzed above. Although the piece ends on pitch class C, the most frequently heard pitch class is G, as shown in the left histogram of Figure 3-7. This alerts us that the most frequently heard pitch class may not be the most stable pitch class. In other words, the tonic, which is defined as the most stable pitch in a piece, may not be the most frequently heard pitch class. All the pitches classes in a piece are heard in reference to the tonic. Hence, even though the tonic pitch class may not be the most frequently heard pitch class on the musical, it is constantly “heard” in the background.

Chu Shui Lian is a variation composed upon the melodic model of *Hakka Da Baban*, referred to in this thesis generically as *Baban*, by treating *Baban* as its cantus firmus (Thrasher, 1989). Since the tonic of *Chu Shui Lian* is ambiguous, we analyze *Baban* to see if it reveals any new hints as to which pitch class should be the tonic. However, the pitch-class distribution of *Baban* also shows G as the most frequently heard pitch class, as illustrated by the right histogram of Figure 3-7, while the other tonic candidate C becomes the third most frequently heard pitch class. Furthermore, there exist a number of variants of *Baban* which are in different lengths and conclude on different pitch classes. The shorter variants of *Baban* end on G, while the others are longer because they have one more phrase at the end, which is a repetition of

two of the inner sub-phrases. This coda-like phrase concludes the longer versions of *Baban* on pitch class C. This is the case for the *Baban* presented here.

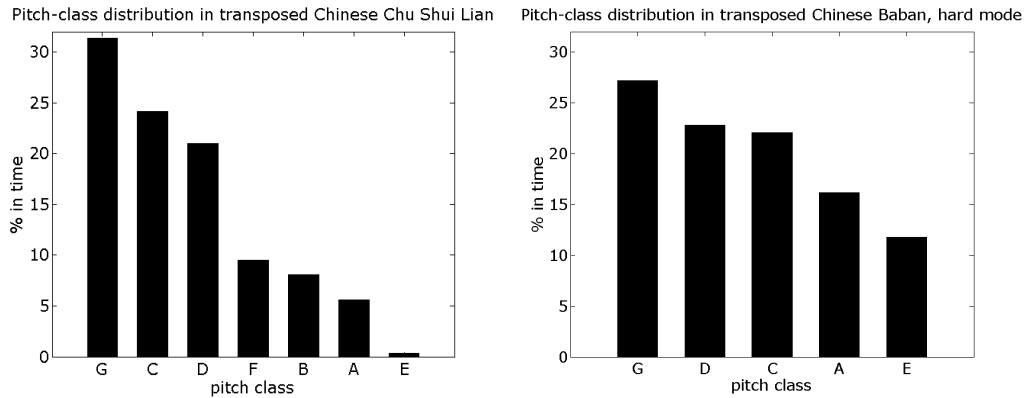


Figure 3-7: The pitch-class distribution of Chinese *Chu Shui Lian* transposed down a perfect fifth (left) and the pitch-class distribution of its cantus firmus *Baban* in the hard mode (right).

Before we continue to investigate whether pitch class C or G is the tonic, we first briefly introduce the other modal characteristics that are not dependent on this decision. The *Baban* presented here is in the “hard” mode, meaning that the third and sixth scale degrees, which corresponds to either pitch class E or A, are more prominent than the fourth and seventh scale degree, which corresponds to pitch class F or B (Thrasher, 1989). In a “soft” mode, vice versa, the fourth and seventh scale degrees would be heard more frequently than the third and sixth scale degrees, as is the case in *Chu Shui Lian*. The “soft” mode is also called the “yi-fan” mode, which literally means the 7-4 mode. Consequently, the cantus firmus of *Chu Shui Lian* may be more directly interpreted as the *Baban* in “soft” mode, which is a variant to the *Baban* presented here. This variant may have come into existence by substituting most of the third and sixth scale degrees with the fourth and seventh scale degrees. The pitch distribution of the *Baban* in “hard” mode is presented here instead because the “hard” modes are strictly pentatonic, while the “soft” modes are modally more embellished by introducing two more tones, the fourth and seventh scale degree.

The original score of *Chu Shui Lian* is in cipher notation, where cipher numeral 1 corresponds to G, while in this study, the piece is transposed down a perfect fifth so that cipher numeral 1 refers to C. The pitch class B presented in Figure 3-7 represents all the inflections of B, from Bb up to a “slightly sharpened” B natural.

By inspection, the pitch classes of *Chu Shui Lian* in Figure 3-7 can be roughly divided into three tiers, as listed in Table 3-4 according to the percentage of time they are heard in a piece. Due to the ambiguity of the tonic, two interpretations of the tonic are presented. The first interpretation treats pitch class C as the tonic. As pitch class C corresponds to cipher

numeral 1, the piece is in “gong” mode. Since the piece emphasizes pitch classes F and B which corresponds to the fourth and seventh degrees over A and E, the name of its mode is prefixed with “yi-fan”. The second interpretation treats pitch class G as the tonic. As pitch class G corresponds to the cipher numeral 5, the piece is interpreted as being in the “zhi” mode. The fourth and seventh degrees in the “gong” mode now become the seventh and fourth degree of the “zhi” mode. Hence, the “zhi” mode is also prefixed with “yi-fan”.

Table 3-4: The tier levels and modal interpretation of the transposed Chinese *Chu Shui Lian*.

Tier levels (pitch distribution)	Pitch classes	Scale degree (yi-fan gong)	Scale degree (yi-fan zhi)
Top	G, C, D	V, I, II	I, IV, V
middle	F, B, A	IV, VII, VI	VII, III, II
bottom	E	III	VI

The term “mode” is used instead of “scale” because the different modes share the same collection of pitches. They are distinguished from each other by which pitch class they tonicize. By choosing a different pitch class as the tonic, the aggregate of intervals between the tonic and all the other pitch classes change, which consequently affects how frequently each pitch class is employed. In Figure 3-8, the five modes, gong, shang, jiao, zhi and yu each tonicizes one of the scale degrees in the basic pentatonic scale, which is given by the gong mode. In addition to the tonic, two other pitch classes are considered structurally more important than the others and they are darkened in Figure 3-8. These three pitches are referred to as the skeletal tones of a mode. If the structurally more important pitches are also the pitches that are most frequently heard in a piece, then the yi-fan zhi mode would be the more preferred interpretation out of the two given above, as all its skeletal tones constitute the top tier in Table 3-4.

The collection of pitches for a mode differs only when it is transposed which is called “modal transformation”, or when a mode modulates from a “hard” mode to a “soft” mode which is called “modal modulation”. In a modal modulation, the basic pentatonic scale is expanded to include the fourth and seventh scale degree by substituting a major portion of the tones on the third and sixth scale degree. This is the case for the two *Babans* mentioned above. The *Baban* in the “hard” mode becomes a “soft” mode through modal modulation. As shown in Figure 3-8, the gu-zheng is tuned to the basic pentatonic scale, the fourth and seventh degrees are played through pitch bend, by adding pressure to the strings tuned to the third and sixth scale degrees.

The figure displays musical notation for various Chinese modes and scales. Each mode is represented by a staff with notes and scale degree numbers below them:

- gong:** 1 2 3 5 6 1
- shang:** 2 3 5 6 1 2
- jiao:** 3 5 6 1 2 3
- zhi:** 5 6 1 2 3 5
- yu:** 6 1 2 3 5 6
- yi-fan zhi:** 5 (6) 7 1 2 (3) 4 5
- 1st Interpret. Chu Shui Lian yi-fan zhi:** 5 6 7 1 2 3 4 5 (Roman numerals: I II III IV V VI VII I)
- 2nd Interpret. Chu Shui Lian yi-fan gong:** 1 2 4 5 6 7 1 (Roman numerals: I II IV V VI VII I)
- transposed "gu-zheng scale":** 1 2 3 5 6 1
- "gu-zheng scale":** 1 2 3 5 6 1

Figure 3-8: The Chinese modes, the two modal interpretations of *Chu Shui Lian* and the “gu-zheng scales”.

After analyzing the pitch-class distribution of *Chu Shui Lian*, we can use the tier system to lay out the pitch space, as illustrated in Table 3-5 for analyzing melodic attraction. Along with the pitch-class transition distribution matrix, the first-order melodic function of scale degrees in the bottom two tiers can be induced. As the tonic is still ambiguous, the tonic level is left blanked and two rows of scale-degree interpretations are given.

Table 3-5: Pitch-stability hierarchy of transposed Chinese *Chu Shui Lian*.

Pitch-stability hierarchy\Scale degrees	I IV	II V	III VI	IV VII	V I	VI II	VII III	I IV
The tonic								
The skeletal tones	C	D			G			C
Pitch classes in the scale	C	D		F	G	A	B	C
All principle sounding pitches	C	D	E	F	G	A	B	C

According to the formula of melodic attraction presented in section 3.2.2, the strong melodic attractions in Table 3-5 are $E \rightarrow F$, $F \rightarrow G$, $A \rightarrow G$ and $B \rightarrow C$. We present the pitch-class transition distribution matrix, as illustrated in Figure 3-9 to see how frequently these melodic attractions are realized. Melodic attractions $F \rightarrow G$, $A \rightarrow G$ and $B \rightarrow C$ are realized as the most frequently heard pitch-class transition. Pitch class E appears when it is not being substituted by F. Therefore, the two pitch classes will not occur in immediate proximity. Instead, the only pitch class that follows E is pitch class D, which is practically its highest attraction state. Hence, all the strong melodic attractions are realized as the most frequently heard transitions.

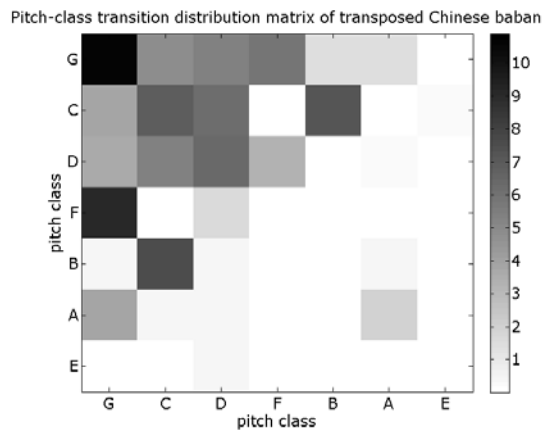


Figure 3-9: Pitch-class transition distribution matrix of transposed Chinese *Chu Shui Lian*.

Since the pitch-class distribution of the melodic model *Baban* was briefly analyzed above, we also perform a first-order analysis on *Baban*. Unlike the earlier first-order analyses that reveal local melodic transitions, a melodic analysis of *Baban* would actually reveal the underlying structural melodic progressions, as *Chu Shui Lian* and the other pieces from the gu-zheng repertoire were partially composed by elaborating *Baban*. According to the formula of melodic attraction presented in section 3.2.2, the strong melodic attractions in Table 3-6 are $E \rightarrow D$ and $A \rightarrow G$.

Table 3-6: Pitch-stability hierarchy of transposed Chinese *Baban*.

Pitch-stability hierarchy\Scale degrees	I	II	III	V	VI	I
	IV	V	VI	I	II	III
The tonic						
The skeletal tones	C	D		G		C
Pitch classes in the scale	C	D	E	G	A	C

In Figure 3-10, we observe that the two pitch classes that most frequently follow E are G and then D, while in *Chu Shui Lian* E was most frequently followed by just D. In *Baban*, pitch class A most frequently transitions to C, itself and then G, while in *Chu Shui Lian*, the order is again reversed, A most frequently transitions to G, itself and then A. Both of the middle-tier pitch classes in *Baban* transitioned to lower attraction states, as structural transitions are more dependent on cultural stylistic idioms. Furthermore, the two darkest cells are transitions to C. One is from the middle-tier pitch class A, while the other is from another top-tier pitch class D. The darkness of these two cells signifies both how consistently it is being approached from the two above-mentioned pitch classes and how C is itself an agogically accented pitch class. This observation may suggest that C is in fact the tonic. In section 3.4.2, the underlying melodic model *Baban* will be analyzed phrase by phrase to reveal its modal orientations.

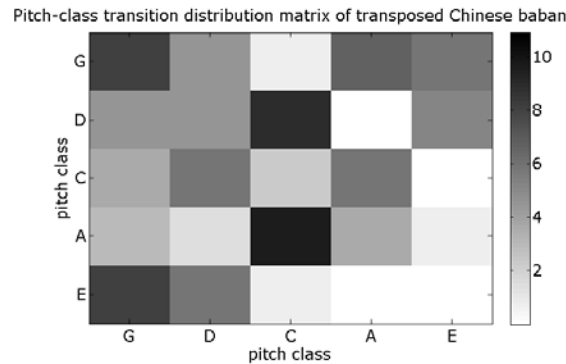


Figure 3-10: Pitch-class transition distribution matrix of transposed Chinese *Chu Shui Lian*.

According to the current zero and first-order analysis of *Chu Shui Lian* and its melodic model *Baban*, the melodic functions of the scale degrees in the bottom two tiers are summarized in Table 3-7.

Table 3-7: The melodic function of pitch classes in the bottom two tiers.

Scale degree	Melodic Function	
	Kind of local embellishment to	scale degree
B	lower neighboring, leading tone to	C
E	Upper, lower neighboring tone to	D, G
F	Lower neighboring tone to	G
A	Upper, lower neighboring tone to	G, C

This concludes our study of the scales and its associated scale-degree hierarchy, as outlined by the pitch-stability hierarchy and characterized by the melodic function of the scale degrees in the bottom two tiers, while the scale degrees in the top tier are the skeletal pitches that provide structural references. With regard to the melodic reduction process, the “stability conditions” used in the time-span reduction sub-process is informed by each culture’s modal system which is approximated by the pitch-stability hierarchy learned in this section.

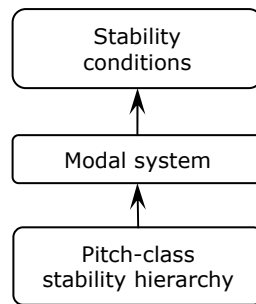


Figure 3-11: “Stability conditions” are informed by the modal system of a culture which is approximated by the pitch-class stability hierarchy learned from its repertoire.

3.3 Meter and grouping

After studying the modal system that characterizes a cultural style along the pitch dimension, we turn to the rhythmic dimension, and investigate how style-specific knowledge is required for inducing the meter and then grouping the melodic surface into units of motives.

3.3.1 Meter induction

Meter, in the western common-practice tradition, is given by the time signature at the beginning of the piece, and implies a hierarchy of strong and weak beats. As illustrated by Figure 3-12, in a 4/4 meter, the four quarter

beats are organized in a metrical grid of strong, weak, strong, weak, where the first strong beat is stronger than the second strong beat as it also articulates the inception of a bar.

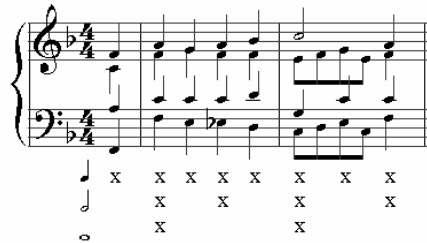


Figure 3-12: A 4/4 metrical grid for the first phrase of the Bach chorale "Christus, der ist mein Leben", extracted from (Lerdahl, 2001).

Meter induction for koto

However, in both the modern transcriptions of the Chinese and Japanese repertoires, a score is often notated in 4/4 for convenience, and does not always reflect the inherent accents of a piece, as illustrated by the first two phrases from the Japanese *Rokudan* in Figure 3-13. Internal accents are shown below the score with numeral labels that indicate the kind of accent employed, as explained in Table 3-8 with reference to Lerdahl and Jackendoff's metrical preference rules (MPR) in GTTM.



Figure 3-13: The first two phrases of Japanese *Rokudan* notated in 4/4, with numbers below showing different kinds of accents.

The third kind of accent specified in Table 3-8 is a style-specific accent. The open fifth 2-note chord is played by plucking two neighboring strings with the thumb and the middle finger simultaneously so that the result is almost a single sound (Adriaansz, 1973). Hence, I categorize this accent as a "timbral" kind of accent, and I borrow a grouping preference rule (GPR) of "change" to characterize this gesture that signals a kind of separation at the metric level. This playing technique is formally known as "kakite", while referred to by musicians as "shan" (Adriaansz, 1973). The fourth kind of accent is labeled in parenthesis when the melodic pattern involved is not an identical repetition of a previous metrically grouped pattern, but a varied repetition.

Table 3-8: The kinds of internal accents employed in the first two phrases of Japanese *Rokudan*, with reference to Lerdahl and Jackendoff's MPR in preference rules in GTTM for metrical structure (Lerdahl & Jackendoff, 1983).

Accent ID	Kind of accent	Description	MPR
1	agogic accent	"relatively long pitch-event"	5a
2	melodic accent	melodic leap	
3	"timbral" accent	open fifth 2-note chord	GPR3
4	parallelism	(varied) repetitions receive the same metrical structures	1

This analysis of inherent accents coincides with how Adriaansz rebars *Rokudan*, as illustrated in Figure 3-14.



Figure 3-14: The first two phrases of Japanese *Rokudan* rebarred, extracted from (Adriaansz, 1973).

Meter in the gu-zheng tradition

In the Chinese gu-zheng tradition, new pieces are composed by subdividing the beats in the cantus firmus notated in a 1/4 meter. As illustrated in Figure 3-15, the length of the original beat is doubled and then subdivided by into two beats to create the 2/4 pattern. This new meter can again be augmented and then subdivided to create beat patterns in even slower tempos. The "ban" can be interpreted as a strong beat, while the "yan" represents the weak beat. In "longer" meters, such as 4/4 and 8/4, the beats are not further grouped into hierarchical patterns of strong, weak, strong, weak. Instead, one strong beat is given at the beginning of the bar to lead a sequence of weak beats. Such a phenomenon is illustrated in Figure 3-16. In this interpretation, the cantus firmus *Baban* in the upper staff is doubled twice as oppose to once in notation for alignment. The lower staff delivers a phrase from *Chu Shui Lian*, which is 4/4 time. The strong and weak beats are respectively shown with the 'x' and 'o' notations employed in Figure 3-15. It is shown that although *Chu Shui Lian* is in a 4/4 meter, there is no hint of an internal accent for a second strong beat in the middle of the bar.

The “second” reason for grouping beyond the metric boundaries, which is listed under the identification number of ‘1’, is informed by style-specific knowledge. For example in the last beat of the second measure of Figure 3-17, the two-note chords, labeled with ‘1’, are grouped into the group that follows as a pick up, due to their strong cohesion with the dotted-eighth note that immediately follows. In execution, the index and the middle finger plucks two neighboring strings simultaneously. The lower pitched tone in the two-note chord is considered the main tone, and is emphasized immediately after by being played by the thumb an octave higher. This three-event long figure is highly idiomatic to the koto, as the index and middle finger naturally spans an octave on the instrument with the thumb. This right-hand playing technique is formally known as “warisume”, while referred to by musicians as “sha-sha-ten”.

Table 3-9: The reasons for grouping beyond metric boundaries.

Grouping ID	Reason for grouping beyond metric boundary	GPR
0	avoid very small groups	1
1	pick up	
2	end on longer durations	
3	melodic proximity	
4	parallelism, varied repetitions receive same grouping	6

Grouping in the gu-zheng pieces are approximated by the grouping of phrases in its cantus firmus *Baban*, which will be illustrated in section 3.4.2. This temporarily concludes our study on group and metric induction. As illustrated above, the grouping and metrical structures are formulated with the help of style-specific knowledge on playing techniques.

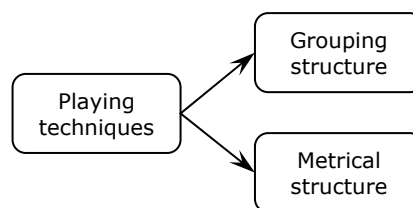


Figure 3-18: The formulation of grouping and metrical structure is informed by style-specific playing techniques.

3.4 Time-span reduction

Now that we have briefly studied both the rhythmic dimension and pitch dimension of the melodic surface with respect to a culture's model system and a specific style's playing technique, we are ready to put them together to uncover deeper structures through the process of time-span reduction, as described in Lerdahl and Jackendoff's GTTM model. The process of time-span reduction is first explained through the reduction of the first two phrases of *Rokudan*. As the goal of time-span reduction is to reveal the underlying melodic progression of melodic surface, the reduction process of the gu-zheng repertoire is approximated by directly analyzing the melodic progressions in underlying melodic model *Baban*. The melodic formulae employed in both of these cultural styles are briefly touched upon, and then further elaborated in the next chapter. Finally, the overall process of melodic reduction is recapped.

3.4.1 Time-span reduction on the koto

Before time-span reduction is carried out, the melodic surface is first segmented into nested levels of time spans, starting from the metrical subdivision level of a quarter beat, as shown by the first row of brackets directly underneath the score in Figure 3-19. As the time-span segmentation works its way up to longer durational levels, segmentation is carried out by subdividing motivic groups instead of metrical groups, as shown by the half-note brackets in the second row. Eventually, segmentation is carried out at grouping boundaries instead of metrical boundaries.

The figure shows a musical score for the first two phrases of transposed Japanese *Rokudan*. It consists of four staves. The top three staves are labeled 'J. level' and contain a melodic line with various rhythmic values and accidentals. The bottom staff contains a bass line with a similar melodic line. Below the staves, there are two rows of brackets. The first row shows small brackets under each quarter note, representing the smallest time span. The second row shows larger brackets that group notes into larger time spans, illustrating the process of time-span reduction.

Figure 3-19: Time-span reduction of the first two phrases from transposed Japanese *Rokudan*.

Time-span reduction starts from the smallest time span, and recursively reduces out events that are relatively embellishing, leaving the more structural events for the next stage, as illustrated by the three staves above the original musical surface. In this study, the structural importance of an event is judged by two rules of thumb. First, in a time span, the pitch in the highest tier is considered the most structural, as the pitch classes in the top tier have the highest degree of pitch stability. This reflects how Lerdahl and

Jackendoff (1985) define structural importance as not dependent on surface salience, but syntactic stability (p.108). Second, if there are more than one event from the highest tier of a time span, the event on a stronger metrical position is retained, or if the events are from the bottom two tiers, both events are retained as a chord as a kind of fusion. The concept of fusion in the context of time-span reduction was introduced in the GTTM model to capture an Alberti bass that is heard as “a single chord spread out over a time span” (Lerdahl & Jackendoff, 1985, p153). In the time-span reduction process, the hierarchical relationship of all the events in a piece is traced.

The time-span reduction process reveals the underlying melodic progression of a melodic surface. As illustrated by the brackets on the top of Figure 3-19, two melodic formulae are uncovered. By referring back to the scale of *Rokudan*, the melodic formulae G to C and C to F can be interpreted as V-I and I-IV. Furthermore, it can be observed that I-IV often follows V-I to make up a phrase. The melodic formulae employed in *Rokudan* are further analyzed in section 4.1.

3.4.2 Time-span reduction approximation for the gu-zheng

The goal of time-span reduction is to reveal the underlying melodic progression of the melodic surface. As the gu-zheng repertoire being studied in this thesis is realized by elaborating the cantus firmus *Hakka Da Baban*, its underlying melodic progression can be approximated by directly analyzing this specific variant of *Baban*, as presented in Figure 3-20.



Figure 3-20: The qu-pai (cantus firmus), *Hakka Da Baban*, with 68 beats in 'hard' mode where C=1, re-notated from cipher notation in Thrasher, 1989 to visualize the contour.

Table 3-10: Phrase-by-phrase melodic analysis of *Hakka Da Baban*.

Phrase	1	2	3	4	5	6	7	8	9
Thematic	a	a'	b	a''	c	b'	b''	b'	b'
Phrase ln.	8	8	8	8	8	8	8	8	4
Function		parallel	contrast						coda
Sub-phrase length (ln.) Rhythmic	3,2,3	repeat	4,4	3,2,3	3,2,3	4,4	4,3	5,4	4
Motivic	abb'	abc	dd'	efg	d'hd'	ij	ik	dj	i
Contour	v\, /, /\	v\, /, ^	\\ ^^/	v, /, ^	^, /, ^	^^, ^/	^^, ^	\\ ^/	^^
Melodic progression	2-1, 5-1, 5-1	2-1, 5-1, 1-5	5-2, 5-2	2-5, 3-6, 6-5	5-2, 2-5, 5-2	2-1, 5-2	2-1, 6-5	5-1, 5-2	2-1
Cadence	1	1-5	2	6-5	5-2	1-2	1-5	1-2	2-1
Goal note	1	5	2	5	2	2	5	2	1

Table 3-10 gives a manual phrase-by-phrase analysis of the underlying melodic model *Baban*. The melodic formulae employed in *Baban* and subsequently in *Chu Shui Lian* will be further discussed in section 4.1.

3.5 The overall process of a informed melodic reduction

The overall process is recapped in Figure 3-21 to illustrate how culture-specific modal characteristics and style-specific playing techniques are incorporated into the sub-processes of melodic reduction.

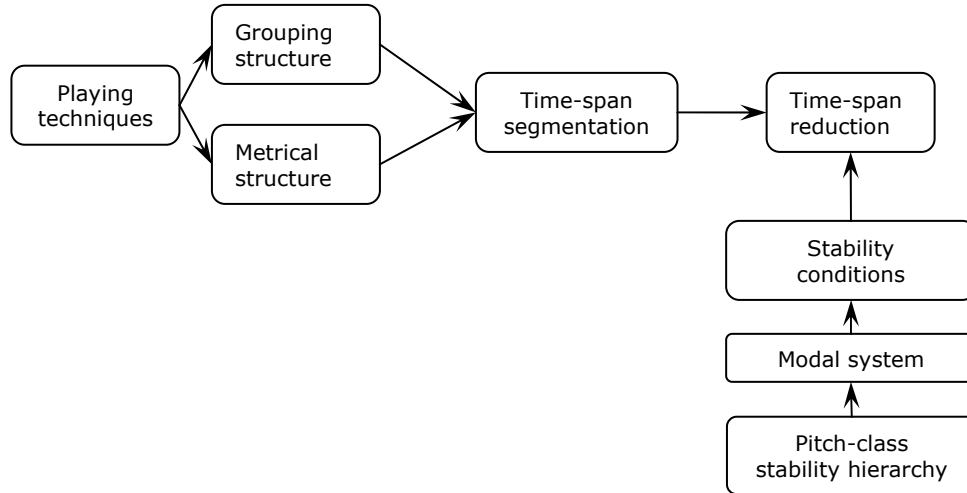


Figure 3-21: The overall melodic reduction process informed by culture-specific modal characteristics and style-specific playing techniques.

In the context of cross-cultural transformation, the process of melodic reduction also functions as a kind of reverse melodic elaboration, by establishing a many-to-one mapping between the phrases grouped on the melodic surface to the melodic formulae delivered by the underlying melodic progression. Such a mapping is many-to-one because an underlying melodic formula can be realized on the melodic surfaces through many different kinds of variations. Hence, in the melodic elaboration process, the melodic formulae on the deep structure can be elaborated by choosing one of the many melodic surfaces through the learned one-to-many mapping.

CHAPTER 4

Cross-Cultural Mappings

Before we proceed to a concrete example of cross-cultural transformation, I first discuss some of the difficulties in such a process with regard to the three structural levels, namely the surface structure, the deep structure and the hyper-deep structure, through a summary of the differences and similarities between the solo repertoires of the Chinese gu-zheng and the Japanese koto studied in this thesis.

In addition to the immediate differences in instrumental timbre, on the level of surface structure, each cultural style demands different sets of vocabularies and grammar, rendering unique sonic experiences. Although the two instruments possess some similar playing techniques, these techniques are employed in different musical contexts. Furthermore, the patterns for local embellishments are based on fundamentally different aesthetics, with the Chinese gu-zheng calling for florid fluidity and the Japanese koto demanding clarity in melodic progression, manifesting the embellishments as wave-like and directional embellishments respectively. Regarding the rhythmic patterns, the Chinese gu-zheng features rapid runs and syncopated figures, while the Japanese koto employs dotted figures extensively. Syncopation is scarce in the *Rokudan*, but abundant in some other pieces in the *Danmono* repertoire, such as the *Shichidan* and *Godan*.

Chomsky believed that there are considerable degrees of similarities between the deep structures of each language, and that these structures would reveal properties that are common to all languages, which were concealed by their surface structures (Wiki). Although on the deep structure, the specific melodic formulae used by the two solo repertoires differ, it is possible to align melodic formulae by their function in modal orientation and then fine tune the evoked degree of tension by altering their surface structures. However, even if there were similar types of melodic formulae across cultures, the importance of a particular melodic formula would differ across cultural styles. For example, there may be an analogical pair of melodic formulae in terms of its modal function across two cultural styles, but one melodic formulae may be heavily used in one cultural style, while the other melodic formulae is rarely used in its belonging cultural style, causing another level of mismatch. Thus, the mapping between melodic formulae across cultures becomes a kind of variation that is dependent on which

properties of a melodic formula to stay fixed and which to vary, whether that be the inherent functional type of the melodic formula or how frequently it is used by a particular cultural idiom.

However, even at the level of hyper-deep structure there is no grammar that is sufficiently universal. The way melodic formulae connect to form higher-level melodic formulae, that is the progression of melodic formulae across sub-phrases, is different in the two cultural styles being studied. Thus, in a cross-cultural transformation, if the hyper-deep structure of the theme is to be the fixed element, its variations in other cultural styles would have to relax their grammar in terms of the sequences of melodic formulae they employ. For example, if the hyper-deep structure of the Japanese koto is chosen to be the basis, this means at the sub-phrase level, the Chinese gu would have to follow its organization, and thus produce a sequence of melodic formulae that are not typical of the gu-zheng style. Moving in the direction towards the infinity of higher-level and longer time-span structures, the solo Chinese gu-zheng and Japanese koto repertoire do have a major resemblance. They are both built from a series of sectional variations in which the tempo speeds up through the sections as one of the features for propelling the pieces forward. However, this structural level is too remote from the musical surface and the various layers of melodic formulae to relate two sets of pieces as a pair of theme and variation.

From the mismatches between the two cultural styles, we can predict that cross-cultural variations encourage an expansion in vocabulary and relaxation of grammatical rules in the cultural styles involved, in order for the "variations" and theme in different cultural styles to be heard as related by theme and variation. Due to the natural propensity of the musical mind, two cultural styles will always have a certain degree of overlap (Figure 4-1), even if these musical universals are not perceived with the same orientation due to cultural contexts. But even if there exist universal principles, they can not be applied if the input does not trigger it (Lerdahl, 2001). In order to increase the kinds of shared musical expressions, not only on the level of surface structure by also other levels of deeper structures as necessary for cross-cultural variations, the boundaries of the core musical expressions of a cultural style are pushed to explore other related musical expressions through the relaxation of musical rules on different musical dimensions (Figure 4-1).

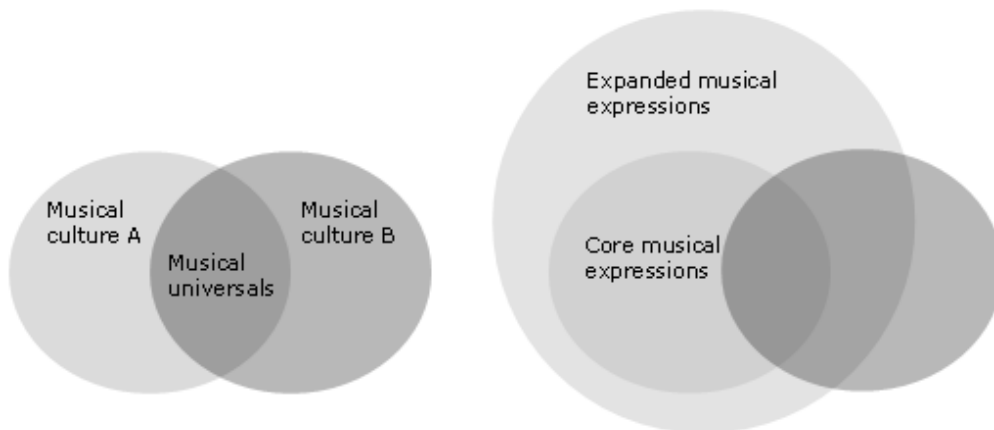


Figure 4-1: The Venn's diagram on the left shows known musical universals as the overlap between musical expressions in different cultures, while the right-hand side diagram shows an increase in overlap when core musical expressions are expanded.

The above observations summarized the similarities and differences of the two cultural styles with regard to the three structural levels. These observations are the signifiers rooted in an underlying signified, the modal system. The sections below discuss the fundamental differences in the modal system on aspects such as melodic formulae and modulation and time.

4.1 Melodic formulae and scale degrees

To understand the characteristics of the underlying modal system of a repertoire, I further my analysis on the kinds of melodic formulae realized in the koto and gu-zheng tradition by focusing on the *Danmono* repertoire, in particular the *Rokudan* piece and the melodic model *Baban* respectively. The melodic function of the scale degrees were analyzed locally in section 3.2 by studying the note-to-note pitch-class transition distribution, and are further analyzed here with respect to their functions in the melodic formulae.

4.1.1 An analysis on melodic formulae and scale degrees in *Danmono*

The melodic formulae in *Danmono*, the solo repertoire of the Japanese koto, have been categorized by ethnomusicologist Adriaansz (1973) into four patterns according to each melodic formulae's overall contour and modal orientation. Table 4-1 lists the four kinds of melodic formulae, with roman numerals representing scale degrees, and contours shown symbolically. The patterns are listed in descending frequency of appearance, as approximated by the first section of *Rokudan*. Adriaansz (1973) also proposes that each pattern is associated with a degree of tension and broadly categorizes the

degree of tension into tension (T) and relaxation (R). The numberings of the patterns are also from.

Table 4-1: The melodic formulae in *Danmono*, the solo repertoire of the koto, listed in decreasing frequency of appearance.

Pattern	Melodic progression	Contour	Tension
1	I to V (IV)	\	R
4	(IV) V to I	/	T
2	V (IV) to I	\	T
3	(VII) I to IV (V)	/	T

The four kinds of melodic formulae all begin or end on scale degree I, V or IV, or their upper or lower neighbors, establishing I, IV and V as the three most important tones in the model system. In the next three paragraphs, I further elaborate their specific roles in the modal system with respect to their function in the melodic formulae and the positions of the melodic formulae.

Pattern 1, a descending pattern which begins on scale degree I, is the most predominant melodic formulae because it serves as both a cadential formula and as the opening figure, delineating the boundaries of phrases. As a result, pattern 1 is also used to conclude all the variations, except the last one, which ends with pattern II, stopping on scale degree I. The functional role served by scale degree I in the melodic formulae demonstrates its stability in the model system, and allows it to claim its status as the tonic. Pattern 2 appears more often than pattern 3 because descending gestures are more frequently called for than ascending ones. The first phrase of *Rokudan* illustrates this phenomenon well as it consists of two phrases, each with two sub-phrases, and all of the sub-phrases employ descending melodic formulae. The progression of melodic formulae for this phrase begins with patterns 2, followed by 1, and then abruptly jumps up to pattern 2 and then continues the descend with pattern 1 again.

As pattern 1 is the cadential formula positioned at the end of all variations except the final variation and does not end on the tonic, it can be thought of as an imperfect cadence. If this is the case, then the scale degree positioned at the end of such a formula would be considered the dominant, which is in common-practice tradition, a synonym to the fifth scale degree, V. However, in the current stylistic idiom, the scale degree in such a position is the fourth degree IV, which is aligned to the subdominant in the common-practice tradition. In terms of structural importance, the fourth degree IV is akin to the dominant, while in local embellishments, it is more similar to the subdominant as it serves as the lower neighbor to the scale degree V, which may precede or follow V. Overall, the predominance of the fourth scale degree in the "imperfect" cadential pattern 1 and in the ascending pattern 4

as the initiator in the melodic progressions towards the tonic establishes it as the lower-dominant. In other words, its role as the dominant is modified by the prefix "lower" because it approaches the tonic from below, through the ascending pattern 4.

The fifth degree V serves as the upper-dominant, as it progresses to the tonic from two octaves above in the final cadence, as a realization of pattern 2. In other pattern 2s, the fifth degree also serves as the solo initiator in the descent to the tonic. Other appearances of the fifth degree include those in the ascending pattern 4, alongside the lower-dominant, the fourth degree, which decreases the fifth degree's dominance in such ascending patterns. Although there are no cadences that end on V, in retrospect, the cadential pattern 1 can also be interpreted as a deceptive cadence, in which V progresses to IV, instead of I. However, in the current context, the progression would be described as from the upper-dominant to the lower-dominant, thus an imperfect cadence.

However, the above is only one of the many interpretations possible, carried out in a comparative fashion with respect to the common-practice tradition. Both insiders and outsiders to the *Danmono* tradition would have their own perspective on what is the most important musical property to defining a scale-degrees function, and if a scale-degree would take on different roles in different contexts. For example, I am also inclined to rename the current fourth degree as the tonic, as pattern I is the only melodic formulae that brings relaxation and a definite sense of conclusion, and it ends on the fourth degree. For different interpretations with respect to semiotics, see Halliwell (1994).

4.1.2 An analysis on melodic formulae and scale degrees in *Baban*

After introducing the prominent melodic formulae and the three most important scale degrees in the solo tradition of the Japanese koto, I proceed to the solo tradition of the Chinese gu-zheng. Since the repertoires being studied for the solo gu-zheng are composed upon the melodic model of the cantus firmus *Baban*, the *Baban* provides the underlying melodic formulae which are elaborated floridly in gu-zheng compositions.

Ethnomusicologists Thrasher presented an analysis on the phrasings and structure of the cantus firmus *Baban*. I further extrapolated the melodic progressions in each sub-phrase, as shown in Table 4-2, in order to extract the melodic formulae. Arabic numerals that correspond to the cipher notations of the gu-zheng are used instead of roman numerals. Roman numerals were used for the koto tradition because in the modal interpretations chosen for presentation, the scale degrees matched to a certain extent the tonic, subdominant and dominant hierarchy implied by the roman numerals. However, in the gu-zheng tradition, the modal orientation diverges from that implied by the roman numerals even further, and more than one scale-degree

is tonicized through modal modulation which introduces different modal hierarchies.

Table 4-2 lists the melodic formulae in descending frequency of appearance, along with the overall tonic of the phrase from which the melodic formulae was extracted. The same melodic formulae may appear in more than one phrase, with each tonicizing different scale degrees, resulting in a short list in the column under "tonic". The overall contours are also given symbolically. When there is more than one turn in a sub-phrase from which the melodic formulae was derived from, a 'w' is indicated as a symbol to wave-like motion. In the above analysis on the koto tradition, tension was already interpreted by ethnomusicologist Adriaansz (1973). Here, I use a similar terminology in terms of the broad classification of tension into just two states, namely tension (T) and relaxation (R), but extend them onto two scopes, namely the "local" and the "global". The "local" addresses the tension evoked by the specific melodic progression in the context of a specific phrase, while the "global" addresses the tension produced by the tonicization of a scale degree with respect to the whole piece. Here assuming cipher numeral 1 as the overall tonic since the piece ends on this tone. The numberings to the patterns indicate their order of appearance in the cantus firmus.

Table 4-2: The melodic formulae in *Baban*, the cantus firmus for a set of solo gu-zheng pieces, listed in decreasing frequency of appearance.

Pattern	Melodic progression	Tonic (local)	Contour	Tension (local)	Tension (global)
4	5 to 2	2	\	R	T
1	2 to 1	1	W	R	R
2	5 to 1	1	/, \	R	R
3	1 to 5	1,5	\	T,R	T
5	2 to 5	2,5	/	T,R	T

The cantus firmus begins in the "gong" mode, as it tonicizes the first scale degree, as represented by the cipher numeral 1. The fifth scale degree serves as the dominant if patterns 2 and 3 are interpreted as perfect and imperfect cadences. According the Chinese modal theory, the first, third and fifth scale degrees are emphasized in a "gong" mode (Chow, 2007), but from the beginning pattern 1 of the cantus firmus, the second scale degree is emphasized instead of the third. This foreshadows a modal modulation to the "shang" mode which tonicizes the second scale degree. By convention, the "shang" mode emphasizes the tones represented by cipher numerals 2, 5 and 6 (Chow, 2007) as its tonic, fourth and fifth scale degree above, which are the second, fifth and sixth degree of the original "gong" mode.

However, modal modulations are often ambiguous, as all the tones employed remain the same, what changes is the modal hierarchy. Another tone becomes the tonic and is emphasized by cadences that end on this new tonic. However, these cadences are usually weaker than that in the original mode. For example in the current scenario, since the "shang" mode is executed in the context of the "gong" mode, the tone in cipher numeral 5 is emphasized more than 6, which is supposedly the dominant of the "shang" mode. Both patterns 4 and 5 emphasize the relationship between tones represented by cipher numerals 2 and 5 and nearly treat 5 as the "dominant" to create perfect and imperfect cadences, although the intervallic distance between the two tones is a fourth and one may think of the plagal cadence. The tone represented by cipher numeral 6 only gains a more structural position in the fourth phrase to reinforce the second scale degree as the temporary tonic, although there is no melodic formula that progresses directly between 6 and 2. Transitioning between 2 and 6 on the level of deep structure involves passing through other melodic formulae. For example, a round trip between 2 and 6 involves sequentially passing through the following melodic formulae, 2-5, 3-6, 6-5 and 5-2, which occurs in phrases 4 and 5 of the cantus firmus.

Above the level of hyper-deep structure, which can be thought of as the melodic progressions at the phrase level, the melodic formulae available in the cantus firmus is either from "gong" to "shang" or from "shang" to "gong". Instead of a modulation between two modes, it can also be interpreted as a progression between tonicizations on the second and first degree, since the modal modulation to "shang" is not a complete modulation as the dominant-tonic relationship is not fully established.

As the "shang" mode is still heard in the context of the "gong" mode, and the structural tones in the "gong" mode are also influenced by the "shang" mode by including its tonic as one of the tones heavily emphasized, it can be said that the mode used by the cantus firmus is in a hybrid "gong-shang" mode. Furthermore, some versions of the cantus firmus are shorted and end on the tone represented by the cipher numeral 5, which invites a tonicization of the 5, and introduces the "zhi" mode. By convention, the tones emphasized in the "zhi" mode are represented by cipher numeral 5, 1 and 2. Hence, pattern 3, which progresses from 1 to 5, and pattern 5 which progresses from 2 to 5, can be reinterpreted as cadences that establish 5 as the tonic in "zhi". Hence, the cantus firmus can be interpreted as a hybrid of the three modes "gong", "shang" and "zhi", or simply as a piece that tonicizes the first, second and fifth scale degree, with the first degree being the overall tonic.

Table 4-3 summarizes the tones emphasized by each of the above mentioned modes by convention and by current cantus firmus *Baban*. These tones are also known as "skeletal" tones due to their structural importance in giving a mode its modal hierarchy.

Table 4-3: The skeletal tones in the modes related to *Baban*.

Mode	Skeletal tones	
	Convention	<i>Baban</i>
gong	1, 3, 5	1, 2, 5
shang	2, 5, 6	2, 5
zhi	5, 1, 2	5, 1, 2

Ambiguity in modality invites subsequent reinterpretations which affect the degree of tension perceived. I will use the piece *Chu Shui Lian* as an example by first explaining its relationship with *Baban*. *Chu Shui Lian* uses *Baban* as its melodic model. However, it does not start from the beginning of *Baban*, instead it elaborates the melodic progression of *Baban* in the following order, as represented by phrase numbers: 3, 1, 2, 4, 5, 6, 7, 8 and 9. Phrase 1 and 2 in *Baban* establishes the tonic, while phrases 3 to 7 elaborate the second and fifth degree. Hence, *Chu Shui Lian* begins by first emphasizing the second scale degree and then progresses to emphasize the fifth scale degree through melodic changes, and eventually establishes the first scale degree as the tonic by going through melodic formulae 1-1, 2-5, 5-2, 5-2 and 5-1. Although the second scale degree is emphasized from the very beginning and carries considerable weight, its dominant, the sixth scale degree does not have prominent presence. Even when it was given a tremolo later in the section, it does not progress to the second scale degree, but instead to the fifth, as an upper neighbor to the dominant of the first scale degree.

The tension of a particular melodic formula often becomes more significant in retrospect when it is contextualized by its surrounding melodic formulae and the over-arching modal orientation. For a specific piece, in the context of a cultural idiom, hierarchical expectation can be learned through multiple listening. Namour (1999) describes all music listening as dependent on the remembering of intraopus, within a piece, and extrapous styles, in order to "recognize similarity between percept and memory and thus to map learned, top-down expectations" (p.441). Huron (2002) describes the expectations associated to a specific work as "short-term", while they learned through acquaintance to a stylistic idiom as "long-term", and further illustrates that short-term and long-term expectations can conflict. For example, familiarity with the melodic model *Baban* would expect that melodic formulae at the beginning of a piece would first establish the first scale degree before establishing the second degree, while familiarity with the specific piece *Chu Shui Lian* would expect the reverse. However, the change in tension that I want to emphasize here is the scenario in which multiple listening of a particular piece would result in different experiences in tension compared to that of the first listening. The column in Table 4-2 labeled "local

tension” approximates that of a first listening, while the “global tension” column describes an additional dimension to tension when we have listened to a piece more than once and are more familiar with the global scheme. Each phrase is then heard in the context of its own inner workings and that the entire piece, giving tension a foreground and a background.

In any case, “gong”, “zhi” and “shang” are closely related modes as they share each others skeletal tones. They are related by the circle of fifths in the same direction. While in the *Danmono*, the closely related modal areas are also those related by a circle of fifths. The opening modal area is stretched to create climaxes by introducing secondary dominants which manifests themselves as either additional dominants or leadings tones to scale degrees other than the tonic, extending the dominant-tonic relationship fundamental to modal hierarchy in the *Danmono* tradition. For example, the second scale degree is sharped to become the dominant of the fifth scale degree V. Additional leadings tones are also used to emphasize scale degrees other than the tonic, for example, the fifth degree is flatted to become the upper leading tone to the fourth scale degree, emphasizing its importance. From the above two examples, the fourth and fifth degree is emphasized, and they are related to the tonic through the circle of fifths, with the fourth degree being the fifth below on the flat side, and fifth degree being the fifth above on the sharp side. Extensive use of secondary dominants in a passage indicates a modulation to scale degree being emphasis, while sporadic or temporary use suggests tonicization.

4.2 Cross-cultural time warp

Each culture perceives time differently in music. This is signified partially by their different paces in establishing and transitioning between structural pitches. For example, on the koto, structural pitches such as the tonic and dominant are established directly, and the time needed to travel between tonic and its lower-dominant is a matter of quarter notes, as illustrated by the upper staff in Figure 4-2. However, on the gu-zheng, to achieve the same kind of modal progression directly, which is atypical on the gu-zheng, a longer and much more active passage is needed, as illustrated by the lower staff in Figure 4-2. The two major differences between the gu-zheng and the koto are further elaborated below.

Time necessary for establishing structural pitches: The time taken on the gu-zheng to establish a structural pitch that is as strong and as stable as that on the koto is a much longer time-span. In contrast to how pitches are established directly on the koto, pitches on the gu-zheng only achieve a similar structural effect when they are established in preceding phrases or sub-phrases. The first phrase in Figure 4-2 in the lower staff is an illustration of how a preceding sub-phrase is needed to establish the pitch that initiates the second phrase and to foreshadow an upcoming less characteristic modal

progression. This is partly due to the fluid character of the gu-zheng music that is contrary to more directed motion.

Time necessary for transitioning between structural pitches: The second phrase in the lower staff of Figure 4-2 shows the passage necessary for a transition from the tonic to the dominant on the gu-zheng, with both the tonic and the dominant established as a stable tone. In addition to its longer length, while the tonic-to-“dominant” modal progression is one of the most heavily called for gesture on the koto, it is not characteristic in the gu-zheng style. The example cited above is the only elaborated instance of such a progression in the melodic model *Baban*.

And due to difference in modal orientation, the closest parallel between a primarily I-V or V-I movement on the koto is that between II and V on the gu-zheng.

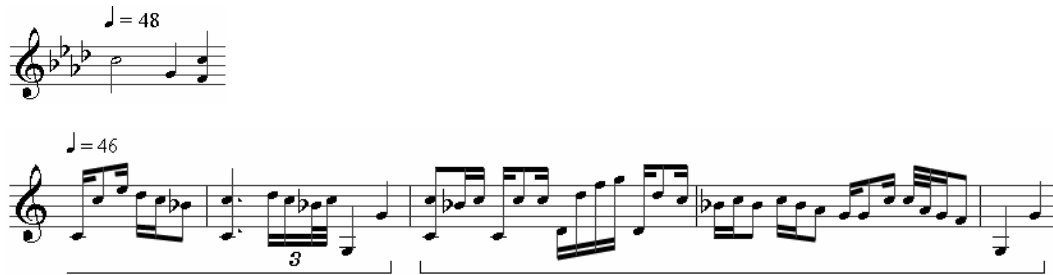


Figure 4-2: The difference in the time span needed to establish and transition between structural pitches on the koto (upper staff) and the gu-zheng (lower staff).

4.3 A short example

After all the discussions on the concept of and the various processes involved in cross-cultural transformation and the melodic formulae characteristic of the koto and the gu-zheng, we are finally ready to embark on a preliminary expedition to approach cross-cultural variation by treating the first phrase of the Japanese solo koto piece, *Rokudan*, as the theme, and compose a variation to it in the style of the gu-zheng. There are four major steps in performing a cross-cultural transformation. In sequential order they are melodic reduction, forward cross-cultural transformation, melodic elaboration and backward cross-cultural transformation, as illustrated in Figure 4-3.

First, we must compose a theme or chose an existing theme in a certain cultural style as the source for later variations. The first phrase of *Rokudan* has been chosen not only because it has been extensively analyzed in this thesis, but also because it possesses one of the characteristics that serves well as a theme. It is rather skeletal, providing a clear sense of direction, which allows more room for ornamental gestures.

The musical score consists of six staves, each with a different instrument or voice part:

- J.S.:** Treble clef, tempo marking $\text{♩} = 60$. Contains a melodic line with notes and rests.
- J.D.:** Treble clef. Contains a melodic line with notes and rests.
- Ch.D.:** Treble clef. Contains a melodic line with notes and rests.
- Ch.S.:** Treble clef, tempo marking $\text{♩} = 46$. Contains a complex melodic line with many notes, slurs, and a dynamic marking *s*.
- Ch.S1.:** Treble clef. Contains a complex melodic line with many notes, slurs, and a dynamic marking *s*.
- Ch.S2.:** Treble clef. Contains a complex melodic line with many notes, slurs, and a dynamic marking *s*.

Figure 4-3: A snap-shot of all the stages involved in a cross-cultural transformation.

4.3.1 Melodic reduction (from surface structure to deep structure)

The theme we have chosen can be divided into three sub-phrases. It starts with the kando, an opening anacrusis, and is followed by a complete phrase that consists of two sub-phrases, with the second being a varied repetition of the kando. The overall contour of each of sub-phrases is that of a descent. Table 4-4 shows the underlying melodic formulae employed by the three sub-phrases and their contours. A detailed illustration of how melodic reduction can be carried out on this particular theme's melodic surface to obtain the underlying melodic progression has been shown in Figure 3-19. The melodic progression in the kando, and subsequently that in the second sub-phrase of the first complete phrase, indexed as phrase 1.2, can also be interpreted as I to V, with the IV acting as an optional figure (Adriaansz, 1973).

Table 4-4: The melodic formulae and its properties in the first three sub-phrases of the *Rokudan*.

Sub-phrase	Melodic formulae	Contour	Tension
kando	I-V (-IV)	\	R
Phrase 1.1	V-I	\	T
Phrase 1.2	I-V (-IV)	\	R

4.3.2 Forward cross-cultural transformation (between deep structure and hyper-deep structure)

This is the stage where we have to search for cross-cultural analogies in terms of melodic formulae in order to map across cultural stylistic boundaries. This process is itself a variation since we have to consider which musical properties of a melodic formula to stay fixed and which to vary. Some of these musical properties of a melodic formula (M.f.) include how frequently it is called for (Freq.), its contour (Cont.), its modal function (Mo.f.) and the tension (T.) it evokes with respect to the current modal area and the specific scale degrees (S.d.) with respect to their modal function.

Table 4-5 shows a mapping of the melodic formulae between the Japanese (J.) koto and the Chinese (Ch.) gu-zheng along all the musical properties mentioned, with reference to the two tables, Table 4-1 and Table 4-2, presented earlier which illustrates the individual musical properties of the melodic formulae employed on the koto and the gu-zheng. Since the third sub-phrase is a varied repetition of the first, its underlying melodic formulae is the same as that of the first, hence it is not included in Table 4-5. The contour (Cont.) column takes into consideration the relative heights of the sub-phrases when searching for cross-cultural analogies. The musical property modal function (Mo.f) is enumerated with respect to the two major modal areas which tonicizes the first and second scale degree, as illustrated by the cipher numerals in the parenthesis. Tension (T.) is also divided as such, with an additional column showing the global (G.) tension, which treats the first scale degree as the overall tonic. Cipher numerals instead of roman numerals are used because tonic of local modal areas are ambiguous.

Table 4-5: The melodic formulae mapped between the two cultural styles, with respect to various musical properties.

J.	Ch.							
M.f.	Freq.	Cont.	Mo.f. (1)	T. (1)	Mo.f. (2)	T. (2)	T. (G.)	S.d.
I-V	5-2, 2-1	1-5	1-5	2-1, 5-1,	2-5	5-2,	2-1	1-5
V-I	2-1, 5-1	5-2, 5-1,	5-1	1-5	5-2	2-5	1-5, 2-5	5-1

If the musical properties chosen to be the fixed elements create major differences in pitch height, the variation will be transposed to match the scale degrees in the theme in order to minimize cognitive distance. In our preliminary experimentation, I choose the scale degree, modal function and contour to be the fixed elements of the theme's melodic formulae, while the varied elements include the frequency of which the melodic formulae are called for and its tension. The hyper-deep structure in this case is twofold. With respect to the fixed and varied elements in theme and variation, the fixed element on the level of deep structure is escalated into the hyper-deep structure. Furthermore, with respect to the recursive hierarchy of structures, the hyper-deep structure is represented by the melodic formulae of melodic formulae, which is the sequence of melodic formulae in a phrase. This structure is adhered in the forward cross-cultural transformation in which the gu-zheng formulae analogical to that of the koto follows the koto's scheme of progression of melodic formulae, which is not typical of that in the gu-zheng.

Figure 4-3 above shows a snap-shot of all the stages involved in a cross-cultural transformation. The first staff, labeled as "J.S." (Japanese melodic surface), corresponds to the theme, which is the first phrase of *Rokudan*. It is transposed up a minor 6th to map the pitch class of the tonic in the gu-zheng parts, which are notated in C for ease of comprehension. The gu-zheng parts are also transposed up an octave to avoid the use of one of the C-clefs and to reduce the number of ledger lines. The second staff, labeled as "J.D." (Japanese deep structure), shows the underlying melodic formulae employed in the theme. The former interpretation of I-IV instead of I-V is notated to illustrate how the contents of melodic formulae can be transformed when mapping across cultural styles for cross-cultural analogies. The third staff, labeled as "Ch.D." (Chinese deep structure), shows the effect of such changes as the fourth scale degrees are mapped to the fifth scale degrees in the forward cross-cultural transformation process. Changes due to transformations are marked in blue.

4.3.3 Melodic Elaboration (from deep to surface structure)

The fourth staff, labeled as "Ch.S" (Chinese melodic surface), elaborates upon the transformed gu-zheng melodic formulae from the third staff. Due to

the difference in perception of time in each cultural style, time is warped. Typically on the gu-zheng, a much longer phrase is needed to achieve the sense of progression given in the first sub-phrase of *Rokudan*, as illustrated in Figure 4-2 and associated discussions. In order to complete the progression in a similar length of time, a short excerpt is selected from the original phrase in Figure 4-2. This minimal figure is in fact one of the least prominent figures in the specific piece from which it was extracted, as it serves as an afterthought to the 5-1 melodic formulae and foreshadows the “real” 1-5 progression in the next phrase. However, the kando figure, from which it transformed, is the most important figure in the solo koto repertoire, serving as the cadential formulae. This creates a vivid cross-cultural contrast between the original figure in the theme and the new figure in that takes over its position in the first sub-phrase of the variation, since these two figures have opposite statuses within their own cultural style. Hence, an insignificant figure becomes significant and undergoes varied repetition each time the kando-like figure is called for. As mentioned above, this transformed figure is preceded in its original context by a melodic progression that transitions from 5 to 1, which fits the second melodic formulae, while the third melodic formulae is just elaborated with that of the first, which as mentioned is a continuation from the second. Although the alignment of the first and four staff shows the illusion that they are about the same length, the original tempo markings show that they are further apart than imagined.

4.3.4 Backward cross-cultural transformation (adaptation of surface structure)

The fifth and sixth staff, labeled as “Ch.S1” and “Ch.S2”, show two versions of how the melodic surface from the fourth staff can be modified to match certain features of the melodic surface of the theme. Or in other words, certain features on the melodic surface of the theme are adapted to that of the variation, which is another cultural style. The goal of these backward cross-cultural transformations is to strengthen the perceived relationship between the theme and the variations.

There are three kinds of surface transformations deployed in the fifth staff pertaining to octave relationships, which are applied with one or both of two goals given below. The first goal of a surface transformation is to preserve the relative pitch height relationships exhibited between the melodic events and the overall contour within each sub-phrase of the theme by matching the register of the theme. The second goal is to mimic the timbral quality of a musical event by matching the “thickness” of the musical event. The three kinds of surface transformations are:

Deletion of octave duplicates: The lower octave of the first two-note chord is removed to match the register and the timbral quality of first musical event in the theme since it consists of only one tone. A second example occurs at the end of the second sub-phrase which also acts as the beginning of the third sub-phrase. The lower octave is again removed, but this time to

achieve an additional goal of maintaining a similar contour for the second and third sub-phrase to that of the theme, so that the lower octave is not sounded until the very end to create an overall descent.

Octave displacement: The tone that was removed in the above octave also appears in the second sub-phrase, but this time as the lower octave of an arpeggiated figure. In the surface transformation, it is transposed up an octave, with the same goal as the example above to maintain the overall contour so that the lower register is touched until the cadence at the end of the third sub-phrase. However, this results in a repeated-tone gesture which is not characteristic of the gu-zheng, which is being taken care of in the second iteration of surface transformation.

Fusion of two consecutive events an octave apart: The last two tones at the end of the first sub-phrase which arpeggiates an octave is collapsed to become a two-note chord. Fusion in this context describes the process of transforming two events into a single event. The same scenario also occurs at the end of the third sub-phrase, as would be expected, as it is a varied repetition of the first sub-phrase. The use of the term "fusion" is inspired by Lerdahl (1983), who uses it in the context of time-span reduction to describe the relationship between the head of a time-span and the events within it: "the head may be the fusion of the events into a single event; or, conversely, the surface events may be an arpeggiation of the head".

After introducing three relatively minor surgeries, a less trivial transformation is introduced with the goal of matching the phrase lengths set up by the theme.

Diminution of figuration: The second and third quarter beat of the second sub-phrase is summarized into one. The first half the second sub-phrase can be thought of as a descent from the highest tone g' to the goal note of the cadence c' , through f' and d' . The first beat summarizes this descent by transitioning from g' directly to d' , without revealing the final cadential note. The second and third quarter beat elaborates upon this foreshadowing to provide wave-like flourishes. Hence, in the current surface transformation, these two bars of florid motion can be combined and reduced to occupy only one quarter beat without making a serious impact on the underlying melodic progression. By comparing the second half of the second sub-phrase to that of the theme, it becomes apparent that in order to establish a structural tone, different lengths of preparation is required, as the gu-zheng demands for an "extra turn" before it proceeds to the next melodic formulae in the next sub-phrase.

Rhythmic assimilation: The sixth staff, labeled as Ch.S2, is the second iteration of backward cross-cultural transformation, with the goal of introducing the characteristic dotted rhythmic pattern to the melodic surface of the variation, in order to create another layer of cognitive links between the theme and the variation. There are four side effects in such a surface transformation, as listed below along with an example from the sixth staff.

Shift in melodic accent: The second quarter beat of the second sub-phrase is expanded into two quarter beats by assimilating the rhythmic pattern in the corresponding phrasal position of the theme. This slightly emphasizes 'f', instead of 'g'. The repeated tones in the following quarter beat are merged to give the dotted-eighth pattern.

Tuning tension: 'f' has a high tendency of "resolving" to 'g'. By transforming the two quarter notes 'f' and 'g' into a dotted-eighth figure, tension is increased because the resolution is delayed.

Melodic reduction and the weakening of linear links: The embellished triplet figure in the first sub-phrase is also reduced and transformed into the rhythmic figure of a dotted-eighth, inspired by the abundance of such rhythmic patterns, and its use in later varied repetitions of the kando. The triplet figure is interpreted as an extension to the first tone c', which bridges its transition to the lower g's, by setting up a slightly interrupted descending motion. The tones 'd' and 'c' are thus treated as an elaboration to the first tone 'c', with the 'd' acting as an upper neighbor. The lowered 'b', which is the seventh scale degree, serves as the lower leading tone to 'c', and must resolve upwards to the tonic. By transforming the triplet figure into a dotted-eighth figure, the first two tones in the triplet is reduced out to give time to the dotted-eighth figure, while the surrounding tones take or give time to resemble the overall rhythmic pattern given in the first sub-phrases of the theme. In this process, the transitional link between the first and last event in the first sub-phrase is weakened. The resemblance between the first sub-phrase and third sub-phrase is also weakened. Since if a similar transformation were to be applied to the triplet figure in the third sub-phrase, its link to a similar figure at the end of the second-phrase would be jeopardized. Hence, continuity was prioritized over non-contiguous links, as the third sub-phrase would still be related to the first through varied repetition. As illustrated above, there are two kinds of "linear" links, the transitional and the motivic. The transitional link links between the musical events in its immediate surroundings, while the motivic link warps time to connect musical patterns that may or may not be contiguous.

Tempo assimilation: The dotted rhythmic patterns replaced some of the more rapid figurations such as the running sixteenths in the second sub-phrase and the triplet sixteenths in the first sub-phrase. This provides the potential for playing the variation at a fast tempo which matches that of the theme. However, since there are still triplet sixteenths in the third sub-phrase, either a ritardando or an augmented version of the triplet figure needs to be introduced in order to for a faster tempo to excel.

CHAPTER 5

Contribution and Future Work

The previous sections proposed a framework for cross-cultural music transformation. This section summarizes the implementation of the core processes involved in a cross-cultural variation, encapsulated in a computer-assisted composition for enabling composers to compose across cultural boundaries and on different hierarchical levels. Future work is discussed along two dimensions, evaluation and further explorations. This section concludes with a brief comment on the effectiveness of variation as an approach to cross-cultural transformation.

5.1 Contribution

This thesis proposed a framework for a systematic experimentation of cross-cultural transformation by approaching it as a kind of cross-cultural theme and variation. The core processes involved are melodic reduction, forward cross-cultural transformation, melodic elaboration and backward cross-cultural transformation. The first three core processes are partially implemented, while the last process is still being refined through manual experimentations. A computer-assisted composition (CAC) tool is being implemented to enable the notion of composing across cultural boundaries and composing on multiple hierarchical levels.

5.1.1 Implementation of proposed transformation processes

To automate a cross-cultural transformation, three encompassing modules that simulate the core processes melodic reduction, forward cross-cultural transformation and melodic elaboration are implemented.

Melodic reduction: This process reduces the melodic surface into its underlying melodic progression. The methodology for the reduction process is based on the framework of Lerdahl and Jackendoff's Generative Theory of Tonal Music (GTTM). In the implementation, in order to model styles outside of the tonal music arena, culture-specific and style-specific knowledge are partially learned and partially hard coded. The sub-processes implemented approximates "grouping" in GTTM through segmentation that is informed by

agogic and melodic accents, and approximates “time-span reduction” by learning pitch-stability profiles from the repertoires being studied. Through the melodic-reduction process, each underlying structural melodic transition is associated with a list of surface melodic segments which can be retrieved upon elaboration.

Forward cross-cultural transformation: This process maps the deep structure between two cultural styles. In the previous chapter, a list of possible musical properties on the level of deep structure was proposed for consideration as the fixed or varied elements in a cross-cultural transformation. Thus far, the musical property scale-degree has been chosen for implementation due to the high-degree of resemblance on the scale-degree hierarchy between the two cultural styles. When an exact match in scale-degree is not found, a “nearest neighbor” that minimizes contour change is searched for.

Melodic elaboration: This process is approximated through a retrieval process that reverses the melodic-reduction process. Given the underlying melodic progression, surface melodic segments are retrieved from the repertoire lists learned from the melodic-reduction process for elaboration. The retrieval process is combined with a search for metric alignment in order to present melodic segments that connect to each other sequentially.

In order to provide a graphical user interface for users to interact with the above modules, a computer-assisted composition tool is being implemented.

5.1.2 Computer-assisted composition (CAC) tool

By learning to compose in different cultural styles, we can expand our compositional palette and broaden the range of emotions we communicate. A computer-assisted compositional tool was conceived to enable composers to:

- 1) compose across cultural boundaries, and to
- 2) compose on multiple hierarchical levels

This CAC tool is being developed in Python, and uses PyGTK for implementing the front-end to the three modules described above which perform melodic reduction, forward cross-cultural transformation and melodic elaboration. The graphical user interface provides three main panels for different kinds of interaction, namely the piano panel, the composer’s-score panel and the library panel. Two of the panels enable different modes of input and feedback.

The piano panel: A floating panel which allows users to enter their melodies either by clicking on the on-screen virtual piano interface or by typing on their computer keyboard. There is also an onscreen computer keyboard that shows the mapping between the computer keyboard and the piano keyboard.

This computer keyboard can also be clicked on directly. Above the leading virtual keyboard are two rows of mini keyboards for feedback. As users compose melodies by “playing” the piano or computer keyboard, each of these mini keyboards will play along, one note ahead, to demonstrate how a particular cultural style would choose to continue their melody by highlighting all the possible keys for the next “moves”. These highlights are color-coded according to how “strongly” a note is being expected. This expectation is dependent on how frequent a particular note appears to follow the current musical context with respect to all the other possibilities. The linear musical context is captured through a variable-length like markov model. The color codes for the highlights on the mini keyboards are listed below in descending order: Green > Blue > Yellow > Orange > Pink > Purple > Red, partially borrowing from the colors of a traffic light to give an intuitive association to the underlying implied flow of a melodic line. Hence, keys highlighted in green indicate the pitch classes that are most frequently deployed under the current considered length of musical context, while keys in red indicate peculiar “moves” that call out for attention and “interrupt” the flow of a line.

The mini keyboards enable users to compose across cultural boundaries, by simultaneously demonstrating how composers in other cultural styles would compose a melody parallel to that of a user, and the user can choose to explore the recommendations at any point. These recommendations represent different levels of significance when being learned from repertoires of different scopes. For example, if the repertoire is learned from just one piece, the recommendations would represent an intraopus style, the style for a specific piece, which may be more dominated by thematic expressions. When the repertoire is learned from a specific composer’s set of compositions, the mini keyboard would take the role of a master demonstrating how she or he would solve a musical puzzle. Each mini keyboard could represent one composer, and the highlights would show each composer’s perspective. If the repertoire is learned from a set of pieces that were composed by different composers but in one particular genre during a certain period in time, the mini keyboard would carry a wider range of expressions. It can demonstrate general stylistic trends by highlighting keys with colors closer to green, and show idiosyncratic preferences with colors closer to red. The mini keyboards can be expanded to include as many rows as possible, with each row showing a different kind of recommendation. The mini keyboards can also be clicked on directly, allowing the users to conveniently follow the highlights through multiple cross-roads. Furthermore, recommendations are not only given on the melodic surface, structural recommendations are given in the “library” panel.

The library panel: This panel is located in the upper-half of the top-level window. It is a panel that provides recommendations in the form of a sequence of notes. When the mini keyboards are giving note-to-note recommendations, the library panel dynamically presents hierarchical recommendations to demonstrate how the structural pitches in the underlying melodic progression can be established and prepared, elaborated and

continued with its multiple tabs. For example, as a user is composing on the piano, the core modules provide possible continuations not only as a list of next possible note events, but also as lists of melodic sequences that are grouped by the next structural pitches to which the current inputs may lead. Continuations in such a form are necessary because the user may be in the middle of a more ornamental figure, and it would be helpful to inform the user of the final destinations of these various trajectories. Hence, the library panel would show how the current piano entries are in the pathway of embellishing or establishing a structural note, and how this structural progression can be continued or prefixed with other melodic segments. For any of the recommendations, the users could click on the score to listen to the sequence, and if they choose to accept this preposition, they can incorporate this sequence into their own melody and skip ahead to start composing again from the next structural note.

The composer's score panel: This panel is located in the lower-half of the top-level window. The notes played on the piano are tracked here and shown in score and guido notation. Users can also choose to enter notes by typing the text-based human readable guido notation. The notes in this panel can be interpreted as the melodic surface, and/or as the underlying melodic progression. For the former case, the melodic progression is extracted from melodic surface to obtain the musical context at the level of deep structure for providing structural recommendations. For the latter case, the melodic progression is interpolated in all the available cultural styles, and the "library panel" would display all these elaborations.

Figure 5-1 and Figure 5-2 below are screen shots of the CAC tool in action. The two floating pianos are in the two figures are in the same state, with the mini piano keyboards highlighting the possible next note events. The upper mini keyboard represents the koto style, while the lower carries the gu-zheng style. Three notes has been entered so far, as shown but the bottom-most "composer's score" panel with a score and a text-entry area with the guido string "[e2*1/8 d a1]". These three notes are currently being treated as the underlying melodic progressions, and the upper-half "library" panel shows the two retrieved interpolations between the three structural notes, with the upper score showing the elaborated transition between the last two structural notes, and the lower score showing that of the first two notes. The upper-half "library" panel in Figure 5-1 shows the structural interpolations in the koto style, while Figure 5-2 shows the corresponding structural interpolations in the gu-zheng style.

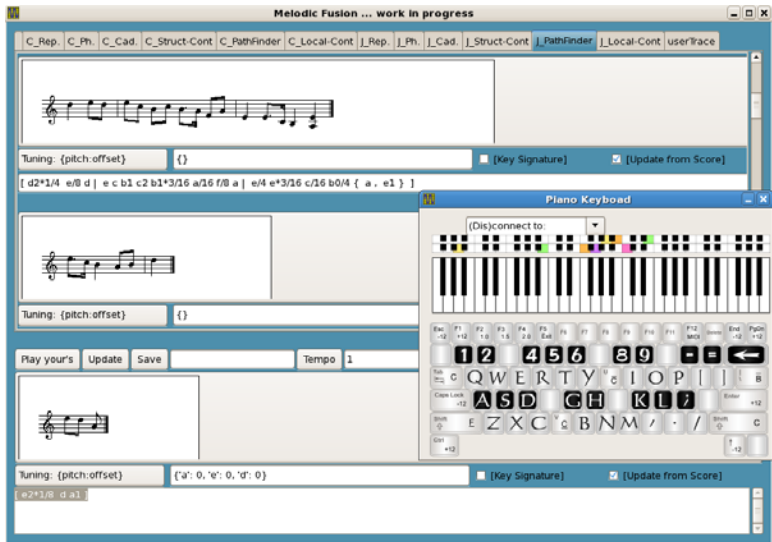


Figure 5-1: A screen shot of the CAC tool performing structural interpolation in the koto style, with the piano showing note-to-note recommendations in both cultural styles.

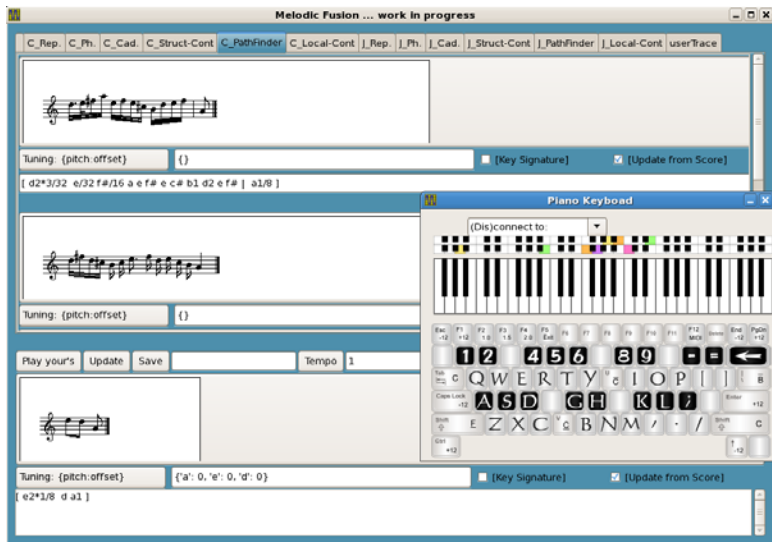


Figure 5-2: A screen shot of the CAC tool performing structural interpolation in the gu-zheng style, with the piano showing note-to-note recommendations in both cultural styles.

The above pair of example show how instead of composing note by note within one cultural style, users can choose to compose at a higher structural level, such as by specifying the underlying melodic progressions of a melody and have the CAC provide realize the musical idea simultaneously in more than one cultural style.

In the implementation of this CAC tool, each musical event is captured in two fashions which consist of the score-oriented (GUIDO) and performance-oriented (Csound) representation. The examples shown thus far illustrate the score-oriented representations. Auxiliary functions are also implemented to provide performance-oriented playback control such as tuning, tempo and transposition which is also related to score-oriented operations. Other ongoing efforts include:

Compositional traces: This functionality allows users to trace their own melody's evolution by making a snap-shot of the current state whenever playback is called for. This allows users another degree of freedom in the process of experimentation, since they would be able to backtrack or revisit any earlier states.

Real-time tweaking: During playbacks, users can adjust the complexity of the elaboration and the degree of influence imposed by a certain cultural style, by interactively switching between the set of possible paths through structural checkpoints.

Interactive world map: A map-like interface on which children can move their pointers across cultural boundaries to hear tunes transformed onto the instruments, tuning, and scales of different traditions.

Backend to the "music painter": "Music painter", developed by Li (2008) for the One Laptop per Child (OLPC) platform, enables children to experience composition through the act of drawing. Furthermore, users can share their strokes as "bricks", which is the building block for the different elements that combine to make a collaborative composition. My modules have been connected to the "Music painter" to serve as a transformative tool to the "bricks", in which different cultural variations of a "brick" can be experimented.

5.2 Future work

The scope of the possible future work is divided into two categories, evaluation and further explorations. The current project has thus far been predominantly the author's own artistic inquire into the existence, and the creative and expressive possibilities of cross-cultural transformation. The scope of the evaluation is twofold. First, the existence and plausibility of cross-cultural variations is evaluated predominately through listening tests. Second, the compositional processes, as assisted by the current computer-assisted composition (CAC) tool, can be qualitative evaluated to reveal how cross-cultural variation can be effective in inspiring and expanding a composer's range of creativity and expressions. A comparative study can also be carried out between composers who are provided assistance from the CAC tool in acquiring a stylistic idiom and those who are not. In both kinds of evaluations, listening and compositional, both the listener's and composer's familiarity with each of the styles involved in the cross-cultural

experimentation are critical factors to be taken into consideration. The Figure 5-3 is extracted from Huron's recent book "sweet anticipation" (2006) to show how different degrees of stylistic familiarity would result in different listening experiences, as illustrated by the levels of uncertainties. A listening test can be further developed to include a "Turing test" between machine-generated cross-cultural variations, human-expert-composed cross-cultural variations, and also human-novice-composed cross-cultural variations in which human novices composed with the assistance of the CAC tool. However, this is not yet a true "Turing test" since there is no real "dialogue" between the interrogator, and the other human and computer. My discussion on evaluation will be focused on listening tests that hypothesize the relationship between the listeners' ability to recognize a cross-cultural variation and their familiarity with the involved cultural styles, regardless of the factors considered in the "Turing test" above.

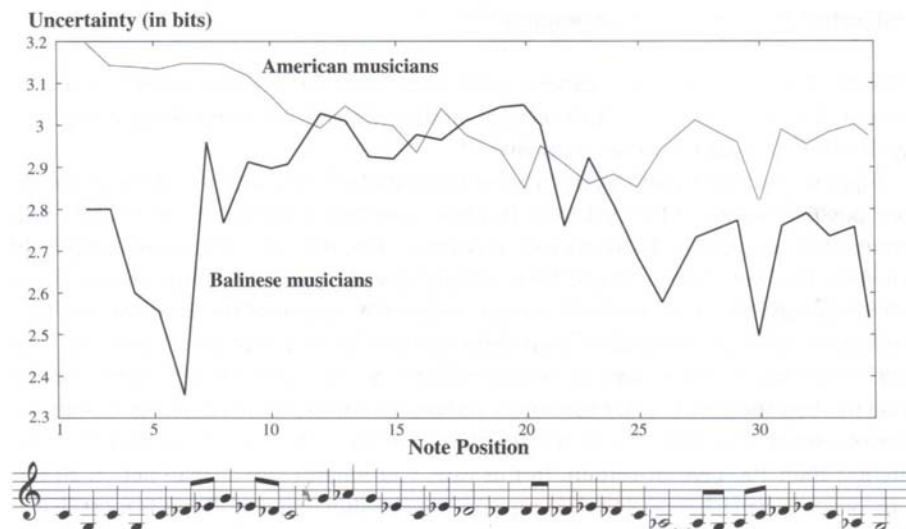


Figure 5-3: "Average moment-moment uncertainty for Balinese and American musicians listening to an unfamiliar tradition Balinese melody. Uncertainty is plotted as entropy, measured in bits" (Huron, 2006, p.52). Figure extracted from the citation. Also, see the citation for a description on the user study.

The current project has focused more on hierarchical modeling between the melodic surface and the underlying melodic progressions. In future explorations, a grammar could be learned for each hierarchical level from the melodic reduction process. For example, the melodic surface can be further divided into two layers, a layer closer to the surface with the playing-technique embellishments and a layer without which is higher-up in the hierarchical structure. Hence, the first layer of melodic reduction on the playing-technique embellished layer is supervised by the layer without playing-technique embellishments, and a grammar can be learned in this process of melodic reduction. This will be elaborated in later discussions. Learning a grammar for playing-technique embellishments is informative and

essential for synthesizing realistic performances and automating the process, as the synthesizer can now be context-sensitive in triggering the appropriate samples and processing effects for a certain context that would by convention call for a certain playing technique. Moreover, hierarchical modeling only captures linear relationships implicitly, and it would be as important to study explicitly the linear processes that connect all the melodic phrases that are reduced to the same underlying melodic progression. These processes may include augmentation, diminution, which would help in aligning different interpreted versions of the same piece. A future goal of this project is to incorporate the modules in a machine-listening system for interactive live performances in which the machine can engage in a dialogue with the performers by rendering cross-cultural variations of what the performer improvises.

5.2.1 Listening tests: Focus on the listener’s familiarity with cultural styles

In composing cross-cultural variations, the goal is to compose a “variation” that possesses a different cultural stylistic identity as the theme and to be related to the theme through variation. Table 4-1, recited from the previous chapter, lists the relevant possible combinations of characteristics possessed by a variation.

Table 2-1: The possible combinations of characteristics possessed by a variation.

Characteristics\ Case	Cultural style A	Cultural style B	Variation of theme in A
1	T	F	F
2	T	F	T
3	F	T	F
4	F	T	T

The cultural identity of a melody is eventually judged by the listener, and this interpretation is highly dependent on a listener’s musical experiences, especially on their exposure to the two or more cultural musical styles involved in a cross-cultural transformation. The table below elaborates this hypothesized relationship between the listener's familiarity with two cultural styles A and B and their interpretations on a variation’s cultural stylistic identity and its relatedness to the theme through variations. Again, the coarse scale of the Boolean is used to simplify the complexity of such an endeavor. For example, the degree of “familiarity” with a cultural style is simplified here into “T” as familiar and “F” as unfamiliar or unknown. The two columns on cultural style A and B are collapsed into one, based on the assumption that a variation can not simultaneously possess two strong cultural identities, replacing the Boolean entries with ‘A’ or ‘B’.

The .1 cases are from the previous table, which made the tacit assumption that the listeners were familiar with both the cultural styles A and B. For example, the case 1.1 is where the listeners, who are familiar with the cultural style A, regardless of their familiarity to the cultural style B, would interpret the variation as bearing the cultural identity of culture A but not related to the preceding theme as a variation. This is possible when the presented "variation" is close enough in style to the theme, making the above interpretation non-substantially based upon the listeners' familiarity with the other cultural styles. Such columns are marked as not applicable (N/A) to reflect that its effect is not fully considered in the current hypothesized study. The .1 cases are used in the current table as the hypothesized ground truths/base cases for comparisons with the .2 and .3 cases. In the .2 cases, listeners are unfamiliar with the cultural style of the theme, while in the .3 cases, the cultural style in which the variation is written in is unknown to the listeners.

Table 5-1: The hypothesized relationship between a listener's background and the perceived identity of a "variation".

case	Listener's background		Perceived "Variation" identity	
	Familiar w/ A	Familiar w/ B	Cultural style	Variation to theme in A
1.1	T	N/A	A	F
1.2	F	N/A	A?	T or F
2.1	T	N/A	A	T
2.2	F	N/A	A?	T or F
3.1	T	T	B	F
3.2	F	T	B	F
3.3	T	F	A?	T or F
4.1	T	T	B	T
4.2	F	T	B	T
4.3	T	F	A?	T or F

When both the theme and "variation" are composed in the same cultural style, as in cases 1.2 and 2.2, listeners unfamiliar with the style may or may not connect a theme to a "variation", regardless if the theme and "variation" are in fact related through variation.

Some listeners may find the two unrelated by variation because they are unfamiliar with the musical vocabulary and grammar of the style and do not know what to listen for, and thus fail to hear the associations.

However, other may think that the theme and "variation" are related, due to two reasons. First, listeners naturally rely on their inherent and learned set of musical faculties to judge what is salient, and if it happens that their learned cultural styles are similar to that of the theme and variation, they maybe able to distinguish the fixed and varied elements. Second, the listeners may very well feel the theme and "variation" are related, because the cultural style itself gives a certain sense of similarity, as in case 2.2, although the theme and "variation" may not be closely related in terms of thematic or melodic structure. And if the listeners were informed that the theme was in a certain cultural style, they may also interpret the variation as being in the same style.

In cases 3.2 and 4.2, although the listeners are not familiar with the cultural style in which the theme was written, they may still be able to interpret if the theme and variation are related through variation because they can rely on their familiarity to the cultural style of the variation to draw the connections.

The .3 cases are those in which the "variation" is in a different cultural style than the theme, and the listeners are not familiar with the former's stylistic expressions. The listeners would either be overwhelmed by the stylistic differences and not be able to hear the connection through variation, or they may stretch the boundaries of their familiar style and include the variation as an experimentation in the same cultural style.

5.2.2 Grammar induction for playing-technique embellishments

The most surface kind of variation technique is ornamentation through playing techniques that are idiomatic to the instruments. In this section, I will focus on the playing-technique embellishments that call for pitch bend to introduce new scale degrees to the existing tuning of the instrument and to duplicate existing scale degrees to ease the execution, as they are some of the most elaborations most relevant to articulating the structure of a piece.

Pitch-bend embellishments on scale-degrees 4 and 7

Since the Chinese gu-zheng is tuned to an anhemitonic pentatonic scale that does not contain any semitones, pitches that create an interval of a second that is less than a major second, which at times approximate a minor second or a natural second can only be introduced through pitch bend executed by the left hand. The two pitches commonly introduced are the fourth and seventh degree created by pressing to increase the tension of the strings tuned to the third and sixth degree.

Two types of embellishment: on the beat or off the beat

Since the fourth and seventh degree is produced by pressing the string, the gesture is often continued or augmented to ornament these scale degrees. The common practice is to subdivide the duration of the tone to be embellished equally and the original tone and the added embellishment would

each take one half. With regard to the gesture, there are two types of embellishments that influence the relative [pitch height and] metric position among the embellishments and the tone being embellished, as explicated in the following.

Type 1: Unaccented upper-neighbor: The embellishment follows the original pitch as a continuation of the pitch bend gesture, and thus occurs on the weaker part of the beat as an upper neighbor.

Type 2: Accented upper-neighbor: The embellishment precedes the original pitch and occurs on the beat by first calling for a deeper pitch bend to create an upper neighbor, then releases the pressure slightly on the left hand to lower the pitch, producing the original tone on the weaker part of the beat.

Need for context-sensitive grammar

However, not every fourth and seventh degree is ornamented. In order to determine which are and what type of embellishment is used, we must consider the context of the scale degrees and their inherent properties in addition to pitch to include duration, metric position, etc. Since we need to know which scale-degrees proceed and succeed the scale degrees being ornamented, a context-free grammar will be insufficient, and thus we explore the possibility of using a context-sensitive grammar.

Table 5-2 shows the immediate context of the fourth degree to illustrate which contexts encourage the use of embellishment and which type of embellishment is employed. It is extracted from Si-Hua Xiang's performance of the first section *Chu Shui Lian*, which is in the mode gong, which means the first scale degree is treated as the tonic.

Table 5-2: The context of the 4th scale degree in the Si-Hua Xiang's performance first section of *Chu Shui Lian*, showing instances where ornamentation is employed or tacit. An underscore indicates the scale degree cited is an octave lower.

Viewpoints	Scale degree (sdeg)						
Type of embellishment	1	2	1	1	1	None	
Preceded by	5	5	2	5	4	2&_	5
Scale degree being ornamented	4	4	4	4	4	4	4
The duration of above scale degree	16 th	16 th	16 th	8th	8th	16 th	16 th
Ornamenting note or figure	5	5	5	5	5	N/A	
Followed by	2	2	2	4	5_	5&_	5&_
Count of occurrence	9	3	5	2	1	8	7

Although the fourth degree is being "embellished" with the pitch-bend playing technique, there is a tendency to treat the fourth degree as a melodic dissonance, due to its proximity to the fifth degree, and how it often is followed and prepared by the fifth, but we must remember its function is in

structural importance equivalent to the third scale degree that it substituted in the “modal modulation” and since in the process of “modal modulation” there is no major change to the other melodic gestures, one may conjecture that fourth degree is structurally functions the same as the third, but in performance, it is convenient to use it as a melodic embellishment naturally introduced through pitch bend.

Two kinds of context for the embellishment: progression or static elaboration

From Table 5-2, we learned that the fourth scale degree when ornamented is always ornamented by its upper neighbor, the fifth scale degree. In both types of embellishments, when the fourth degree is a 16th note, preceded by the fifth degree, it resolves to the second-scale degree, as if an escape tone. When the fourth scale degree is an 8th note preceded by the fourth degree, it returns to the fourth degree, functioning as a neighboring tone. When the fourth scale degree in 16th-note value is preceded by the second scale degree, it returns back to the second scale degree. We can thus further comment that embellishment to the fourth degree is employed in two kinds of context, making it part of a progression or a static elaboration.

Context-sensitive grammar (CSG) with only scale-degree represented:

Progressive context:

Type 1: 5 4 2 -> 5 4 5 2

Type 2: 5 4 2 -> 5 5 4 2

Static-elaboration context:

Type 1: 2 4 2 -> 2 4 5 2

5 4 4 -> 5 4 5 4

4 5 5 -> 4 4 5 5

Only capturing the scale-degree is insufficient. The CSG can be represented in viewpoints, a descriptor for a certain musical property (Conklin & Witten, 2008), capturing each note event as a features set (Conklin & Bergeron, 2008). For example the first CSG above can be described as follows to capture more musical properties, in this case the duration (dur) in addition to the scale degree (sdeg):

[{sdeg:5}, {sdeg:4, dur:16th}, {sdeg:2}] -> [{sdeg:5}, {sdeg:4, dur:32nd}, {sdeg:4, dur:32nd}, {sdeg:2}]

5.3 The effectiveness of melodic variation as an approach to cross-cultural transformation

In the tradition of theme and variation, composers are often experimenting with different variation techniques and procedures that transform and develop a musical idea through different musical dimensions. Cross-cultural variation can be thought of as an expansion of the concept of “characteristic variations”. As illustrated in Bach’s “Goldberg Variations”, each characteristic variation takes on a special character, such as a march or dance of some kind. For example, variation 7 has the quality of a gigue which was originated from the British jig, while variation 19 is a minuet which was a popular dance in France (Green, 1979).

By treating cross-cultural transformation as a kind of variation, we are actively engaged in exploring how the various cultural styles involved relate to each other, and we hear each cultural style in the context of others, in the process of searching for the possible fixed and varied elements of a theme. By comparing the styles, we encounter similarities and dissimilarities across the styles. Through the similarities, we discover the elements of musical expressions that are shared among cultural styles, and can propose cross-cultural analogies on different levels of structure. Through the dissimilarities, we can experiment with different degrees of mutual adaptations to reveal the hidden potentials of certain musical expressions.

By exploring different cultural styles in the context of cross-cultural variations, we are offered new perspectives to think about same material. These perspectives often lie outside of our ordinary mindset, the common set of possibilities that we image. Cross-cultural thinking provides us with a concrete set of possibilities to enrich our musical imagination. We are led to new ways of experiencing time. A certain musical figure that is insignificant in one cultural style may be perceived as valuable when viewed from the lens of another cultural style, and be given a life. For example in the short cross-cultural transformation illustrated in Figure 4-3, an afterthought which was subordinate to other musical phrases was brought to the forefront and begins to serve as a kind of opening and cadence. Through cross-cultural variation, from the micro to macro, alternative ways of adjusting tension and gaining momentum, of phrasing, organization and presentation are introduced.

Not only does cross-cultural variation expand the scope of possible variation techniques, it encourages us to think in the mindset of other musical expressions. As these musical expressions carry the thinkings and feelings of other cultures and individuals, cross-cultural variation fosters deeper understanding and shared empathy between cultures, appreciation for diversity, and enables us to communicate across cultural boundaries to build stronger bonds around the globe.

CHAPTER 6

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