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Visual design system for music education for children

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Visual Design System for Music Education for Children

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Overview

According to *The Theory of Cognitive Development in Children* by Jean Piaget (A developmental psychologist well known for organizing cognitive development into a series of stages, 1896 –1980), children gather and retain information more quickly when visually displayed than just verbally stated. Based on this theory, this thesis candidate agrees that using both visual and verbal methods of teaching may improve the understanding of musical components (major scale, melody and harmony) for children. Therefore, it is expected that logical and effective visualization can enhance the level of musical comprehension for children because visual explanations help to improve children's retention of information. The purpose of this thesis is to develop a simple and understandable visual system to convey complicated concepts of musical composition for 1st grade music students. The abstract ideas of major scale, melody and harmony are redefined and expressed appropriately through visual communication. Thus, the visualization of musical sound in this thesis can contribute to the development of music education for children.

Graphic Design Problem

The graphic design problem of this thesis is an exploration to express abstract and complex ideas through simple visual solutions. This thesis will propose a method of visualization to convert abstract ideas into graphic design solutions, and show how this method can amplify or diffuse abstract ideas.

Outside Content

For the application component, this thesis concentrates on translating complex musical language into the simple and clear language of visual elements, which will help children aged 6 to 10 understand basic principles and concepts of music with accuracy and ease.

This thesis benefits human society because it helps foster the mutually useful relationship between graphic design and the music education field, and contributes to the development of a new teaching method of music education for children.

Thesis Project Definition

Situation Analysis

Most music classes for children aged 6 to 10 currently use traditional teaching methods of musical notation. For example, only musical notes on a sheet and other difficult musical signs or symbols have been used in music classes. Some teachers may use clapping to denote the musical beat and rhythm. Others may use the Kodaly method (hand signs of musical scale developed by Zoltan Kodaly, see appendix A) to help children understand musical scale. However, none of these methods seem to be satisfactorily effective for children to use major scale, melody and harmony. For example, a traditional music score has difficult and complex phonetic symbols, notes and signs which children must learn and memorize before they learn actual musical notation. Therefore, modern music education needs to find a more effective alternative to convey musical components to children.

The challenge of this thesis is to explore visual communication as a viable means to present information that is inherently abstract, complex and non-visual. This visual system of music will be introduced to children aged 6 to 10 in beginner's music classes. The primary audience of this thesis is graphic design students and professors, and the secondary audience is music educators. For the primary audience, this thesis will be an example of expressing abstract and non-visual ideas through graphic design solutions. For the secondary audiences, this thesis will provide a more effective way to teach music for children.

Goals

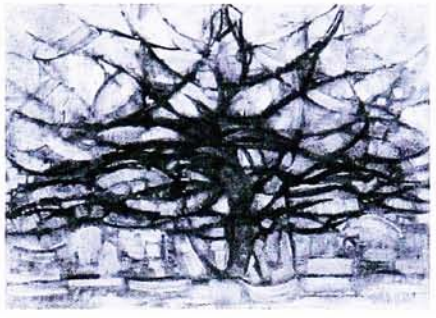
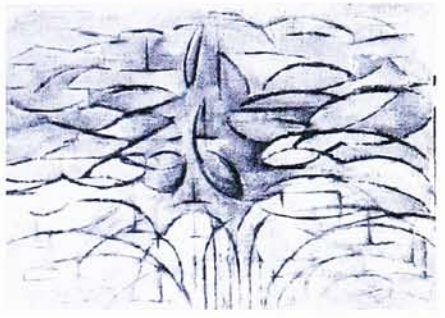
- To identify specific visual elements and show how the treatment of those elements can amplify and diffuse abstract and complex ideas
- To provide an increased understanding of the major scale, melody and harmony through the development of an effective, appropriate visual language
- To present the possible use of graphic designs as an alternative teaching material in music education for children

The work of the painter Piet Mondrian (1872–1944) illustrates a lifelong effort to distill and document the rhythmical essence of our visual world. For example, here are some of his tree studies, made over a three-year period, in which he successively eliminates representational characteristics and amplifies the underlying rhythmic patterns. This perspective can be seen in his last painting of this tree sequence, in which the dynamic rhythms of the complex branching of a tree are transcribed into a simple and harmonious visual painting. His work also shows a simplified image through visual elements.

Figure 1.1
Piet Mondrian
The Red Tree (1909), The Gray Tree (1911), The Flowering Apple Tree (1912). Collection of the Haags Gemeentemuseum, The Hague

Visual Awareness and Design
Philip Thiel
Seattle, University of Washington Press, 1981
p 226

Impact Statement
Mondrian changes complex and difficult images of actual objects into more simplified and concise ones by effectively applying design elements such as lines. This simplification process is relevant to this thesis in the aspect of converting complex and difficult ideas into more concise and simple ones.

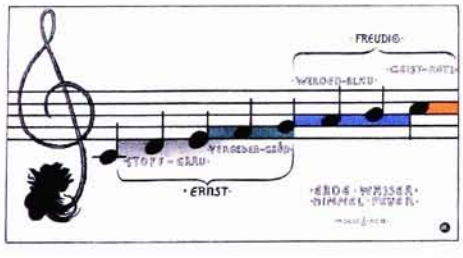




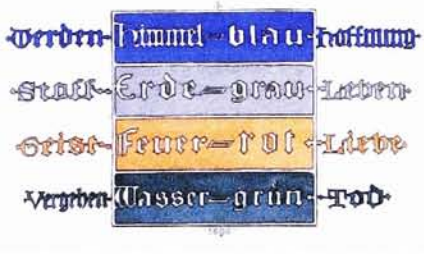
This is a graphic series by the Bavarian artist Josef Sattler entitled *Meine Harmonie*, which appeared in Berlin in 1896. Josef Sattler proposed to measure a basic relationship derived from a musical octave in which the colors grey, green, blue, and red are arranged in succession. It was the first attempt made to understand a color system based on theoretical analogies between music and color composition. This study introduces musical notation as related to understanding nature and emotion, supplying a color-coding system that associates comparable meaning between music and color.

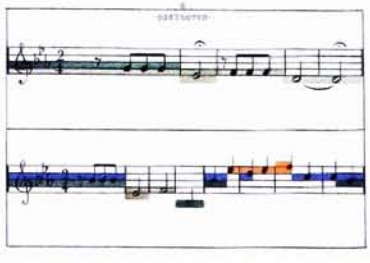
Figure 1.2
Meine Harmonie
Josef Sattler

Analogías Musicales
Javier Arnaldo
Fundación Caja Madrid, 2003
pp 40, 41

Impact Statement
Sattler used several colors to express music on the musical sheets. This attempt is one of the ways of presenting musical composition with a visual language, and it is helpful for this thesis to develop into a more effective visualization on the basis of Sattler's color-coding system.







Precedent

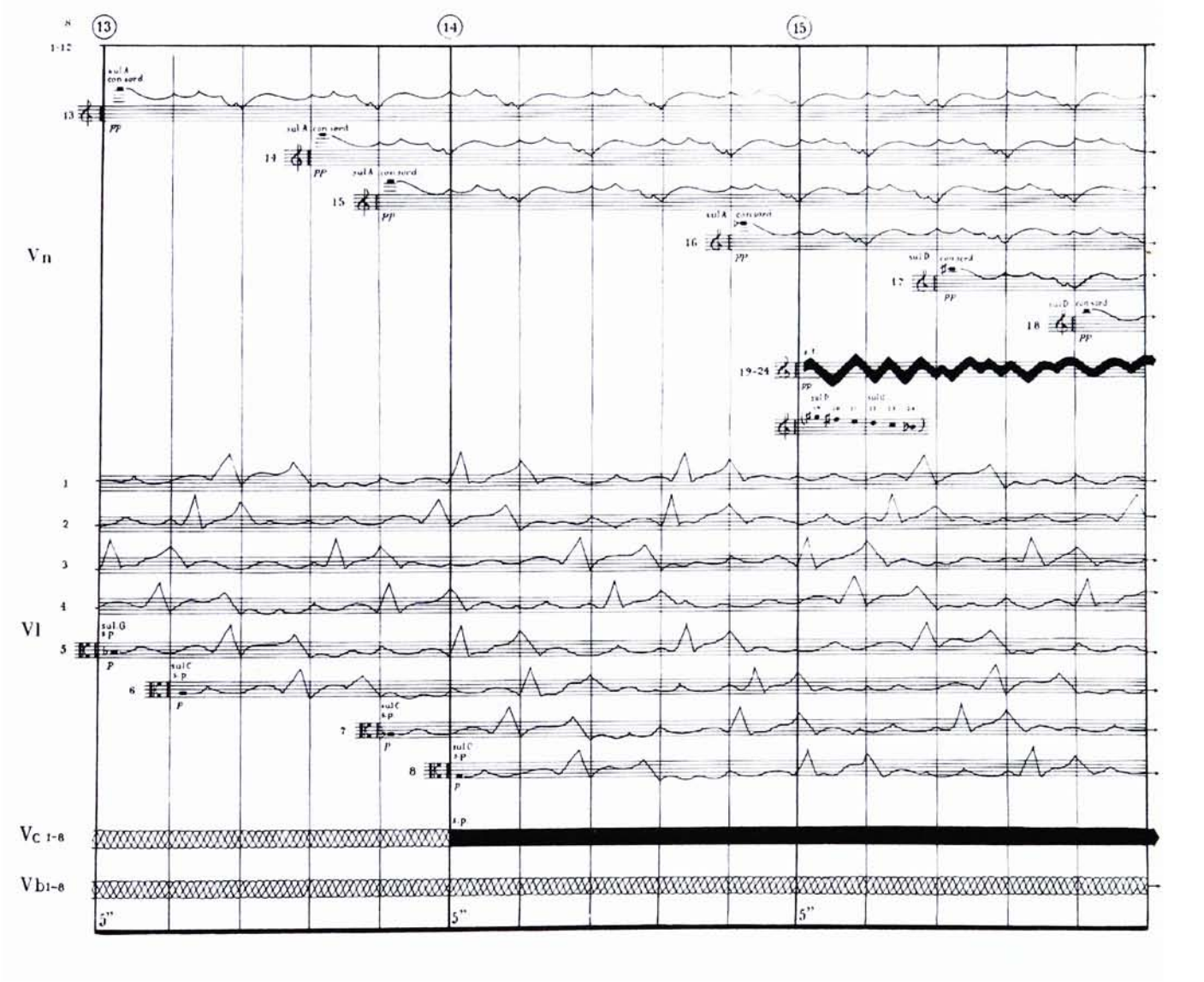
This example shows another possible way to represent sound with visual accompaniments. This means the system could produce any kind of score, including those in which musical time is not measured by traditional rhythmic symbols. Special symbols and layouts could be manufactured and placed in libraries, as needed, text could flow freely within the score, and the score layout could be configured in any way one imagined. In addition, it proves ideal and unmatched for quickly making musical examples for use in scholarly publications and in teaching.

Figure 1.3
The Score of Krzysztof Penderecki's Polymorphia

The Science of Musical Sound
John R. Pierce
New York, Scientific American Library
1983
p 14

Impact Statement

The system of specialized symbols and layouts describing melodic pattern is similar to this thesis in that it documents musical components in visual form.

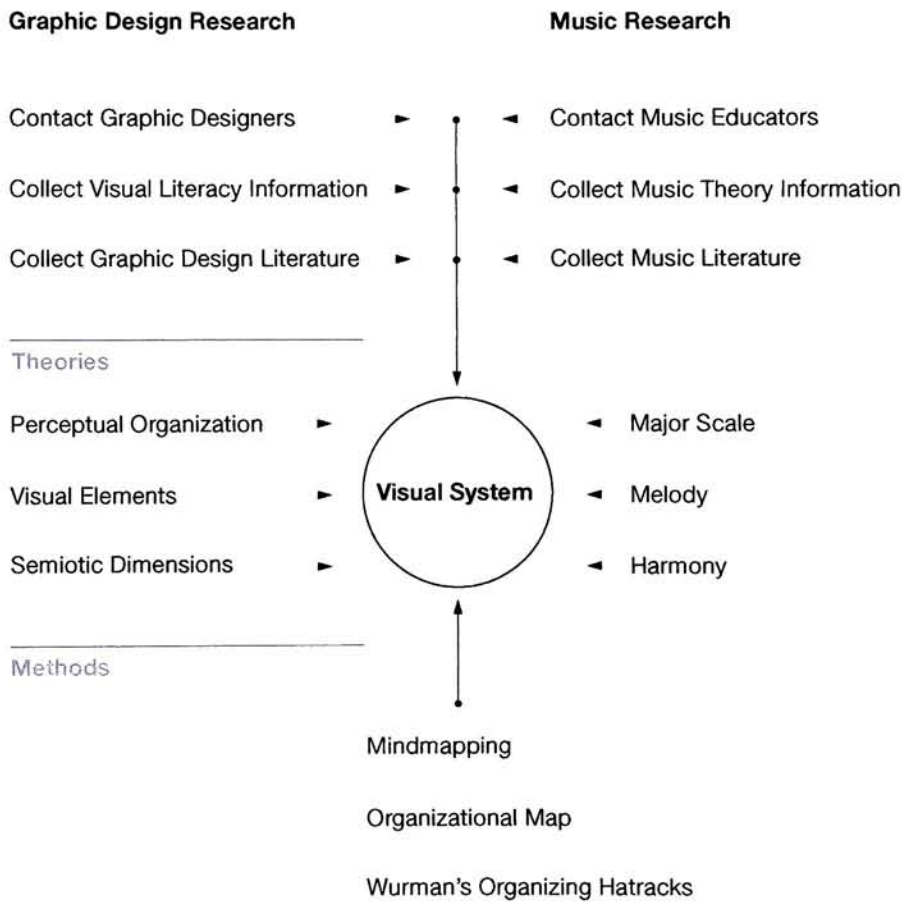


This thesis research identifies various aspects of the number, position, direction, shape, color, texture, and surface-quality attributes in the visual field. It also considers the process of perception, which is the interpretative activity children use to ascribe meaning to these optical differences in the visual field.

The music research for this thesis includes fundamental music theory and musical components. This research begins with the analytical understanding of the major scale, melody and harmony.

Research Process

The research process involves more than a mere gathering of facts; it requires a planned process of organizing information from a range of diverse resources. The diagram below synthetically presents both graphic design and music research processes.



The conditions that facilitate the organization of a heterogeneous visual field have been specifically identified as *proximity, similarity, continuance,* and *closure* by the Gestalt psychologists, and these elements were formulated as 'law'. Gestalt psychology focused on visual perception, and was developed by German psychologist Max Wertheimer in the early 1920s. These psychological studies and resulting theories help to explain visual perception as a meaningful whole.

Proximity

The Law of Proximity states that the relative closeness of some elements to each other as compared to others at a greater distance will cause the closer elements to be seen together as a new entity. The greater the relative physical proximity is, the stronger the tendency is for a visual association. This is the simplest condition for relating discrete elements into larger wholes.

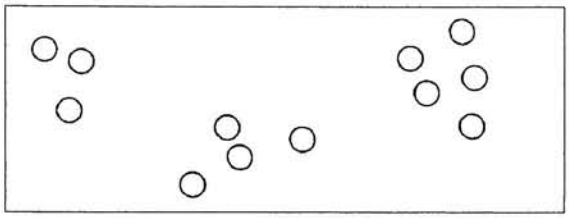
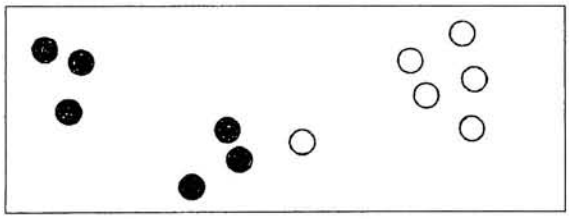


Figure 2.1
Visual Awareness and Design
Philip Thiel
Seattle, University of Washington Press, 1981
pp 158, 159

Since some of these twelve identical elements are closer to one another, they are seen as three groups.

Similarity

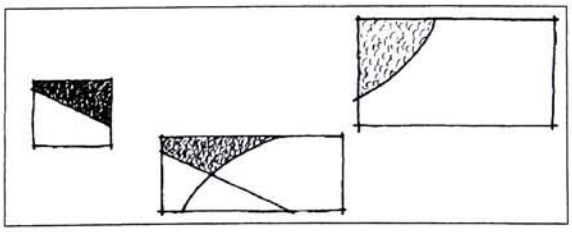
The Law of Similarity states that the commonalities of attributes of a number of separate elements tend to relate them as a group. Similarities in form, size, direction, color, or texture will serve to associate a variety of discrete units into a new and larger whole. Note that this organizing tendency may be in competition with the Law of Proximity and, if so, will produce a perceptual 'tension' in the visual field.



This same spatial pattern of elements can also be organized into two additional groups through the use of similarities in the elements.

Continuance

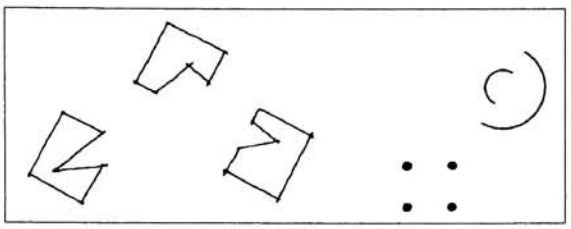
The Law of Continuance states that continuation and similarity of image occur even when nonessential material is removed from the visual statement. These similarities may also appear when progressive changes happen in size, shape, direction, hue, value, chroma, or texture. Continuance also applies to consistencies in the direction and linear character (straight, curved, jagged, wave) of the 'in-lines' (lines within) or outlines (bounding contours) of the adjacent images.



These forms are related by the linear continuance of their 'in-lines' and outlines, and by a change in value.

Closure

The Law of Closure states that our perception tends to group certain visual elements by 'filling in' the gaps between them to establish one simple, larger form. The form displays closure when the separated elements are identifiable.



Notches in the squares form a triangle; four dots produce a square; and two curved lines suggest a solid ring.

The Language of Vision
Gyorgy Kepes
Dover Publications,
1995

The laws of proximity, similarity, continuance, and closure in the spatial structuring of the elements of the visual field are previously introduced in this thesis. However, in the *Language of Vision*, Gyorgy Kepes (A Hungarian-born American painter influenced by Bauhaus design, 1906–2001) organizes these elements on a higher order: in terms of their rhythmical patterning. He writes:

"Rhythmical patterning of the picture surface can exist on as many levels as the differentiations of the visual field. If a surface permits any subdivision that repeats its own shape or size in a smaller form, a simple geometrical order is achieved. This subdivision implies sizes, positions, directions, and intervals. When the orderly measure of the optical units is related to their virtual movement from and to the picture-plane, a higher level of rhythm is reached. We have then a rhythm of the plastic forces, a regular change of sensation of spatial movements of colors and values; advancing, receding, expanding, contracting, moving up, down, left and right. Finally we might have orderly changes or repetition of more complex configurations of visual experience; rhythmic order of tension and repose, concentration and rarefaction, harmony and discord. Rhythm may be simple, restricted to one or another metre of the optical differences. It may also be compounded, as two or more lawfully varying metres existing simultaneously. Rhythms may correspond with and amplify each other, or they may oppose each other, causing a higher level of rhythmic configuration."

This rhythmical organization is significant for this thesis because it starts from the idea of transforming musical rhythm into a visual system. Therefore, Kepe's way of rhythmical patterning can be used to express music in visual forms.

In *Visual Explanations*, Edward R. Tufte (A professor emeritus of political science, computer science, statistics and graphic design at Yale University, 1942~) describes design strategies—the proper arrangement in space and time of images, words, and numbers—for presenting complex information about motion, process, mechanism, cause and effect. These examples suggest that clarity and excellence in thinking is very much like clarity and excellence in the display of data. When principles of design replicate principles of thought, the act of arranging information becomes an act of insight.

Design strategies for depicting quantities include direct labels (for example, the numerically labeled grids of statistical graphics) and encoding (color coding). Using several design strategies, the visual application (Figure 2.2) shows the storm within a three-dimensional tripod of scales and directional arrows. Six small clouds depict a history of the storm and also serve as three-dimensional tick marks for the red timeline, which flows left to right as time passes. The small, still, spatial sequence of images provides a context for the large, moving, temporal sequence above.

This example is relevant to this thesis because it shows the clouds' speed, quantities and other complex factors in a more simple visual structure, and this process of simplification gives this thesis candidate the idea of visualizing complex musical composition. In addition, the design strategy of expressing the quantities of three-dimensional clouds became a motive expressing the beat of the music in this thesis. Beat is one of the essential parts when expressing the melodies of music in relationship to duration.

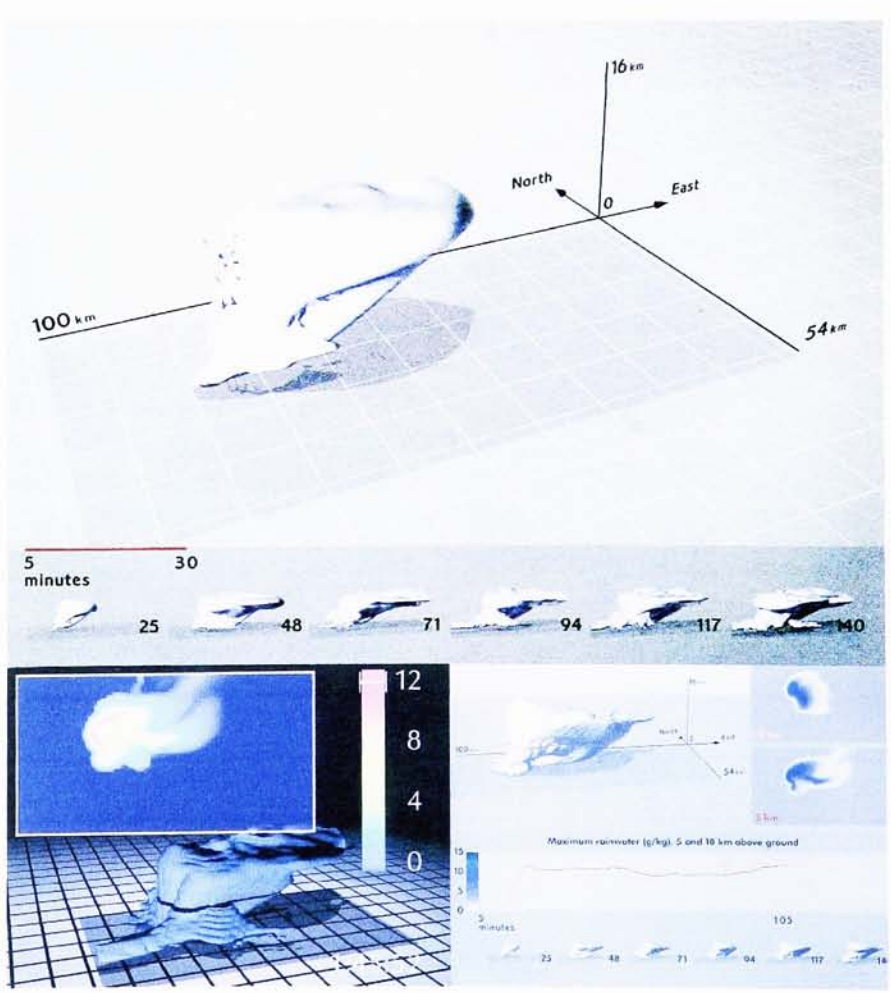
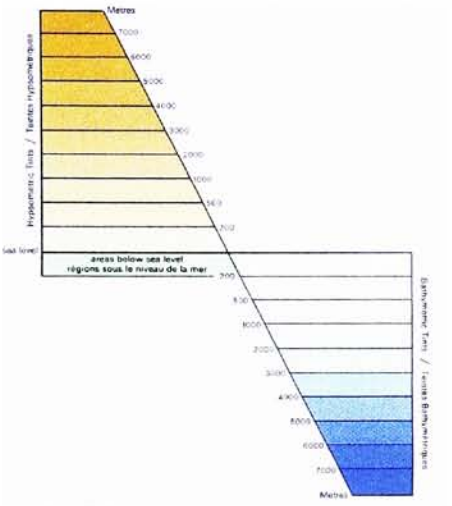


Figure 2.2
Visual Explanations
Edward R. Tufte
Graphics Press,
1997
pp 21, 23, 75

Figure 2.3
Visual Explanations
Edward R. Tufte
Graphics Press,
1997
p 76

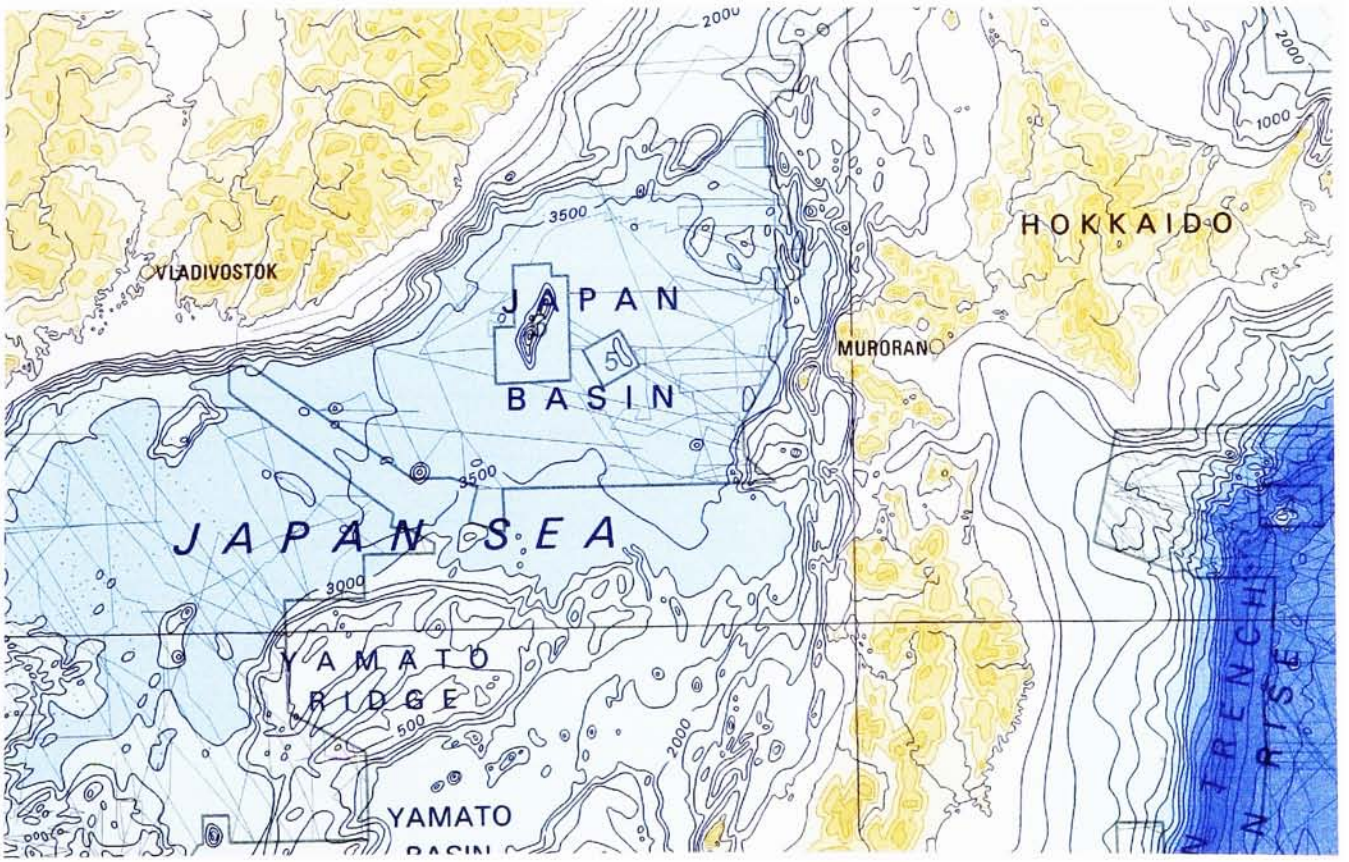
General Bathymetric Chart of the Oceans,
International Hydrographic Organization
(Ottawa, Canada, 5th edition, 1984)



Tufte states in his book, *Visual Explanations*:

"Showing the Japan Sea and the great trenches of the Western Pacific, this classic map below makes extraordinary use of small and effective differences. The General Bathymetric Chart of the Oceans depict (the blue, bathymetric tints) an altitude (tan, hypsometric tints) in 21 color gradations—with "the deeper of the higher, the darker the color" serving as the visual metaphor for the color scale. To indicate depth, the contour lines are labeled by numbers, a design that enhances accuracy of reading and nearly eliminates any need to refer back to the legend. Every color tint on the map signals four variables: latitude, longitude, sea or land, and depth or altitude measured in meters. Then, on a visual layer separated from the blue tints, thin gray lines trace out the routes of the oceanographic ships that measured the depth (outside of areas with detailed surveys, such as ports and coastlines). These gray lines are a small miracle of information design. Floating on top of the ocean and coexisting with the blue tints and contours, the thin lines depict a distinct, second layer of data relevant to depths below. There is sufficient visual space for the gray lines because the representation of depth does not use up all the informational possibilities of color in the map. And since the contours are directly labeled with numbers, the fine distinctions in blue remain clear and readable. By indicating depth with visually minimal gradations in color, the cartographers were able to add an extra two—dimensional layer of gray line data right on top of the ocean contours. Minimal differences allowed more differences."

This example is significant to this thesis because it enhances the understanding of depth of the land or ocean even in two-dimensions. The idea of using the gradation of one selected color in converting major scale into the visual system came from this method of geographic mapping.

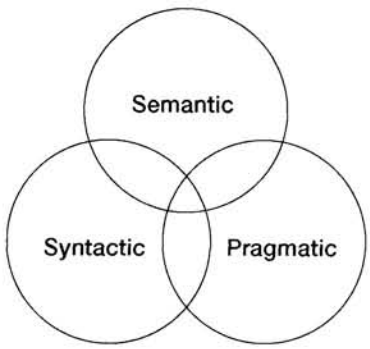


A Semiotic Approach to Designing Messages

Professor Deborah Beardslee

Design Theory and Methods Seminar
Rochester Institute of Technology,
School of Design
2005

The semiotic model represents the three dimensions of anything designed: meaning, form, and use. It can be a useful evaluation tool to isolate each of these three dimensions to determine how well a design solution satisfies the appropriate goals of a solution. This structure serves as an outline for designers to simplify and organize complex problems. This model provides a mechanism for generating and evaluating a visual system to explain complex ideas. This thesis uses a semiotic approach to form more systematic and organized ideas from complex ones. More specifically, this thesis candidate uses this approach to synthesize the elements of each semantic, syntactic and pragmatic dimension and selects some relevant elements from each dimension in the Synthesis section to organize the thesis.



Semantic
Meaning, concept

Meaning
concept
content
hierarchy
message
symbols
words
idea

Perception
emotion
Gestalt

Communication
accuracy
clarity
appropriateness
integrity
language
readability

Syntactic
Formal, aesthetic

Form
composition
hierarchy
proportions
balance

Structure
grid system
rhythm
white space

Variables
position
size
shape
texture
tone
weight
color

Pragmatic
Technical, functional

Ergonomics
accessibility
environment
human factors
legibility
lighting
visibility

Production
fabrication
materials
tools
processes

Specification
schedule

Distribution
interactive
mailed, posted
static, kinetic
time-based

When teaching music in the elementary classroom, music teachers must decide which methods are most effective. One of the most popular teaching methods is the Kodaly approach. Developed by Hungarian composer and music educator, Zoltan Kodaly (1882–1967), this method advocates the use of a series of hand signs presented in conjunction with the major scale. Kodaly and his colleagues chose to use hand signs developed by John Curwen (1816–1880) to reinforce intervals among pitches. Pitch is defined as highness or lowness of sound.

The Kodaly approach is very significant and closely related to this thesis because it is the most popular method in modern music education to accelerate the understanding of music. It is a foundation of expressing pitches with the visual shapes of hands, and it has been proven that this approach helps students better understand the musical scale. Therefore, this suggests that the visualization of musical composition is an effective way of teaching music.

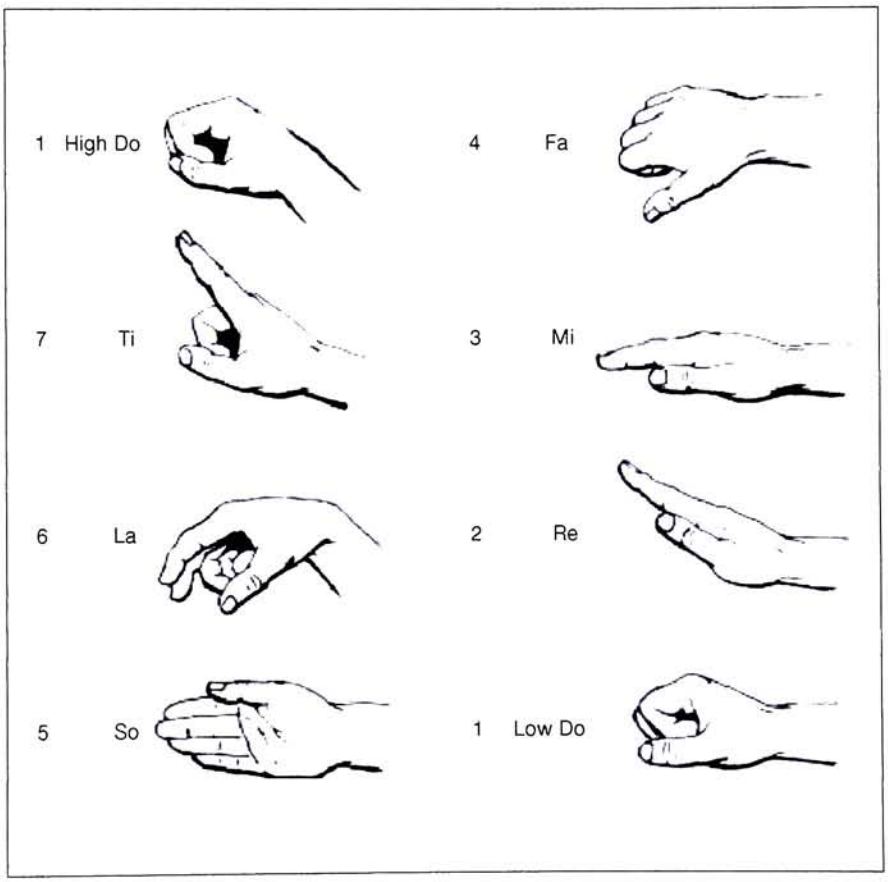


Figure 2.4
Hand Signs
http://www.iks.hu/literacy.htm

A scale is a sequence of related pitches. There are many different kinds of scale, but what makes each one unique is the pattern of intervals each one follows from the starting pitch—referred to as the root or tonic—ascending to that same pitch played an octave higher.

The most commonly used scale is called a major scale. You can hear it if you play the white keys on a piano from low C to high C. The sequence of keys can be either ascending or descending—that is, they start from the lowest key or the highest key respectively.

The major scale is defined as a specific pattern of small steps (half steps) and large steps (one steps) encompassing an octave.

A half step is the closest pitch above or below any given pitch in western music. Using only the white keys on the piano, there are two half steps in each octave. In other words, as you can see in the piano keyboard below, the gap between the C and D keys which have the black key in between is called 'whole step', and the gap between the E and F keys with no black key between them is called 'half step'. Therefore, all the structure of the major scale consists of 'whole step—whole step—half step—whole step—whole step—whole step—half step'.

When E—F and B—C keys are half steps, the scale is called 'C major scale'. This thesis uses the basic C major scale as a typical example in the Ideation section.

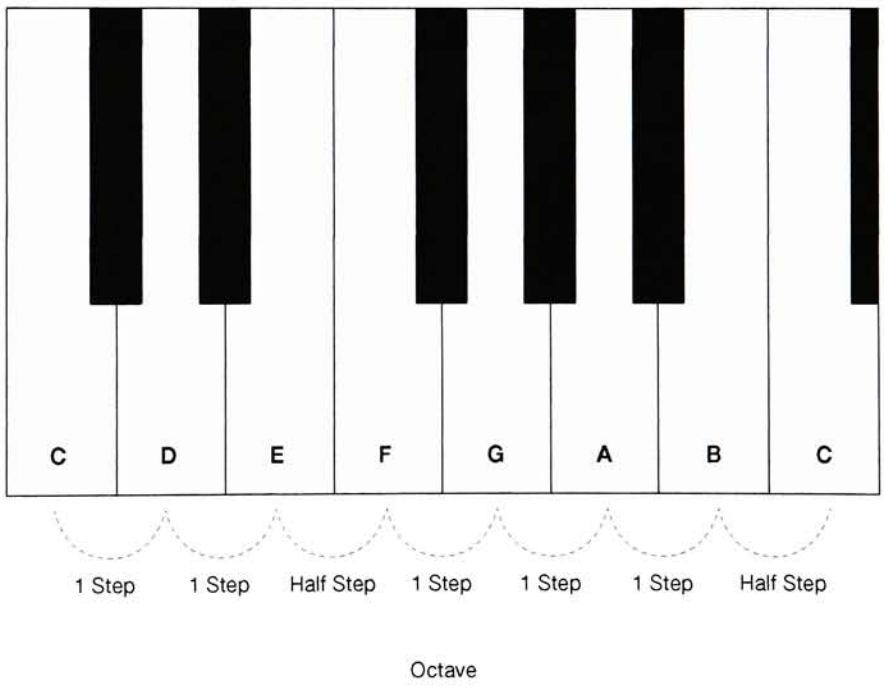


Figure 2.5
The Major Scale

Tonal Harmony
Stefan Kostka, Dorothy Payne
McGraw-Hill College,
2004
p 6

An interval is the measurement of the vertical distance between two pitches, as opposed to the horizontal distance (time). A harmonic interval results if the pitches are performed at the same time, while a melodic interval occurs when the pitches are played successively (Figure 2.6). The method of measuring intervals is the same for both harmonic and melodic intervals. As can be seen in the example below, melody and harmony can be distinguished more clearly through the understanding of each intervals.

Figure 2.6
Intervals

Tonal Harmony
Stefan Kostka, Dorothy Payne
McGraw-Hill College,
2004
p 17

Harmonic Intervals Melodic Intervals

Melody

Melody is defined as a group of pitches (highness or lowness of sound) played one after another, which appear as a line of notes that move upward or downward, depending on the kind of notes selected. As an entity, the repetition of pitch is an important factor in any melody. Melodies also have melodic pitches that rise and fall, and they are perceived as high and low. In the Ideation section of this thesis, the grid system will be used to structure the sequence of melodies.

Harmony

Harmony is defined as an aspect of music that pertains to simultaneous combinations of pitch. The combinations of different pitches enhance the quality of music. It is the sound that results when two or more pitch classes are performed simultaneously. It is the vertical aspect of music, produced by the combination of the components of the vertical aspect.

Rhythm

Rhythm is defined as the variation of the duration of sounds over time. In other words, it is a combination of different note lengths (see Figure 2.7) in a piece of music; of even and uneven sounds that convey a sense of movement in time. This thesis candidate researched rhythm because it helps to better understand melody. Rhythm of music will be expressed in the Ideation section of this thesis.

Figure 2.7
Note Lengths

An Introduction to Music
Martin Bernstein
Prentice-Hall,
1972
p 6

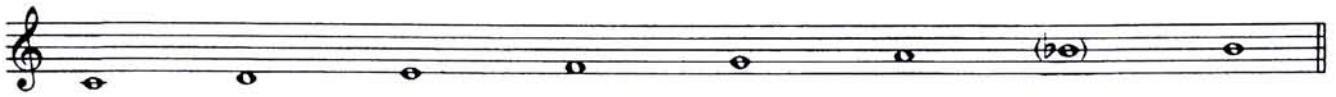
Whole-note Half-note Quarter-note Eighth-note Sixteenth-note Thirty-second-note

Figure 2.8
Scale Degree Names

Tonal Harmony
Stefan Kostka, Dorothy Payne
McGraw-Hill College,
2004
p 94

Musicians in conversation or in writing often refer to scale degrees (names of a particular note of a scale in relation to the tonic, the first note of a musical scale) by a set of traditional names rather than by numbers. The names are shown in Figure 2.8. Notice that there are two names for 7 depending on whether it is minor or major.

The actual alphabetic names of each key are provided to help better understand the numbers and the traditional names.



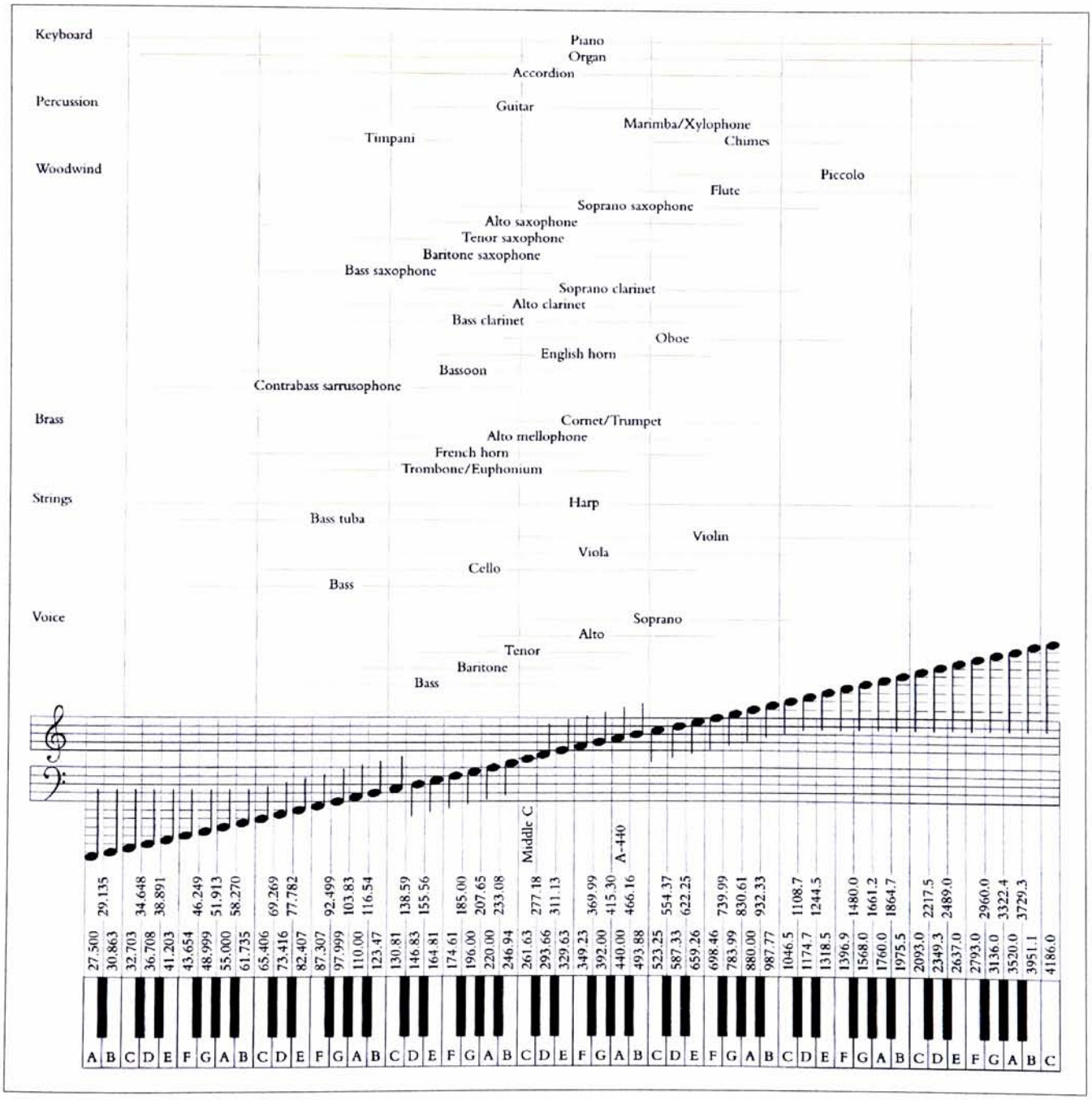
Tonic	Supertonic	Mediant	Subdominant	Dominant	Submediant	(Subtonic)	Leading Tone
1	2	3	4	5	6	7	7
C	**D**	**E**	**F**	**G**	**A**	**B flat**	**B**

Figure 2.9
Parallelism

Visual Explanations
Edward R. Tufte
Graphics Press,
1997
p 87

Multiple parallelism is a natural design strategy for explanations of music and sound, as repeated comparisons are made with respect to frequency and time. This example shows many overlapping parallel tracks associated with the 88 keys of the piano keyboard. Frequencies of sound, notes of the musical scale, ranges of singing voice, and families of musical instruments are aligned, described, compared, and contrasted.

This example shows that high frequency represents high sound and low frequency is for low sound. This is a highly relevant fact for this thesis because the major scale is expressed in the Ideation section based on pitch and frequency.



The wave theory of sound was consulted to understand physical sound in harmonics. The longest wave is 'C' in an octave and 'red' in the threshold of the visible spectrum. Also, the shortest wave is 'B' in an octave and 'violet' in the threshold of visibility. For instance, as can be seen in Figure 2.11, the wave ratio of each C, E, G (1:4/5:2/3) which is the most important harmony in the major scale, is equal to that of red, green, blue (1:4/5:2/3) as seen in Figure 2.10.

This wave theory of sound is relevant to this thesis because it provides an individually related color for each key in an octave. Individual colors are used to show each musical key in the Synthesis section of this thesis.

Figure 2.10
Color Wavelength Spectrum
www.usbyte.com/common/approximate_wavelength.htm

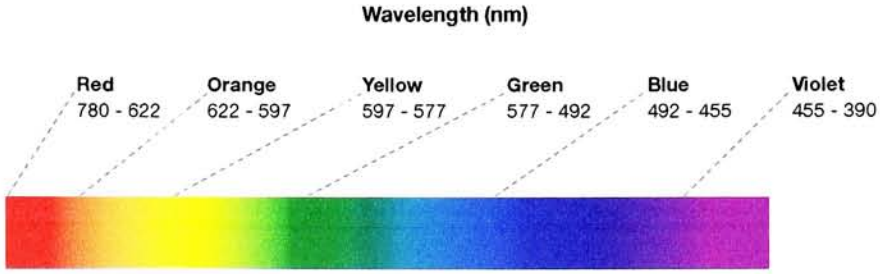
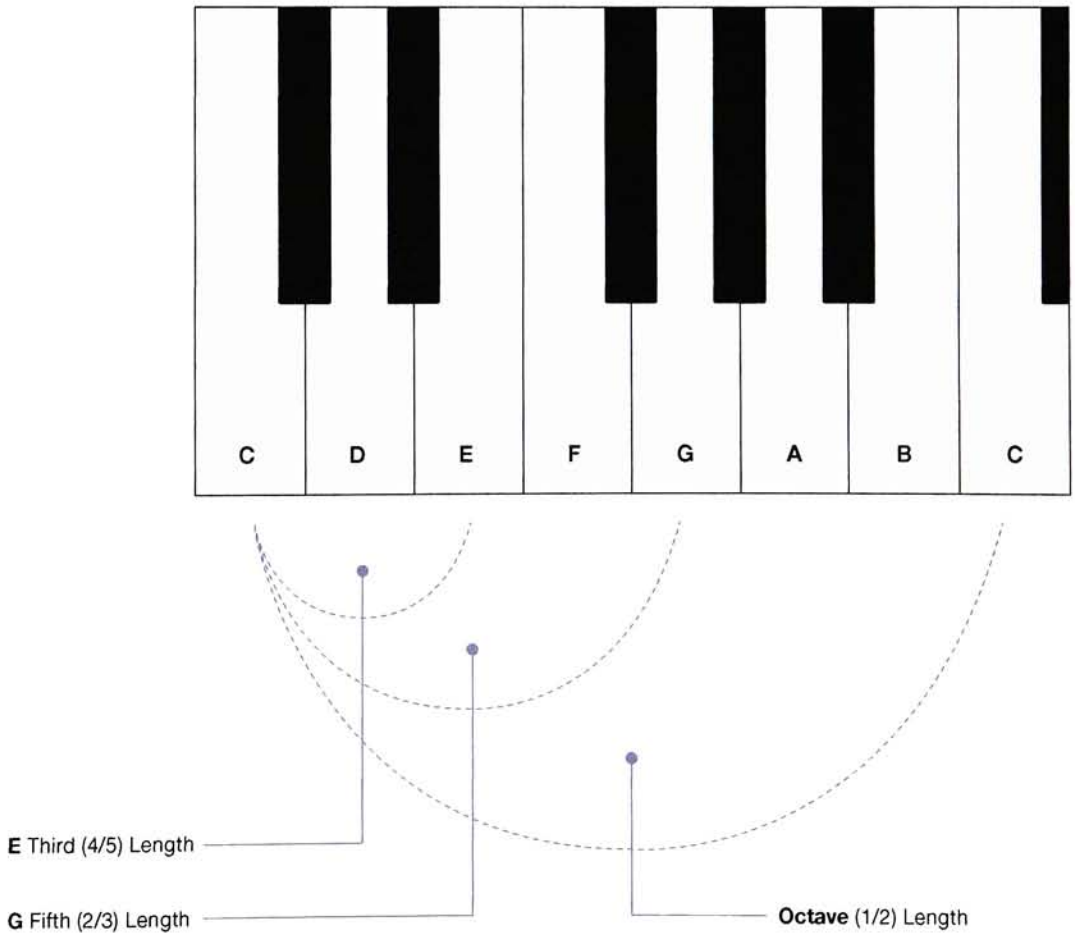


Figure 2.11
The Wave Theory of Sound

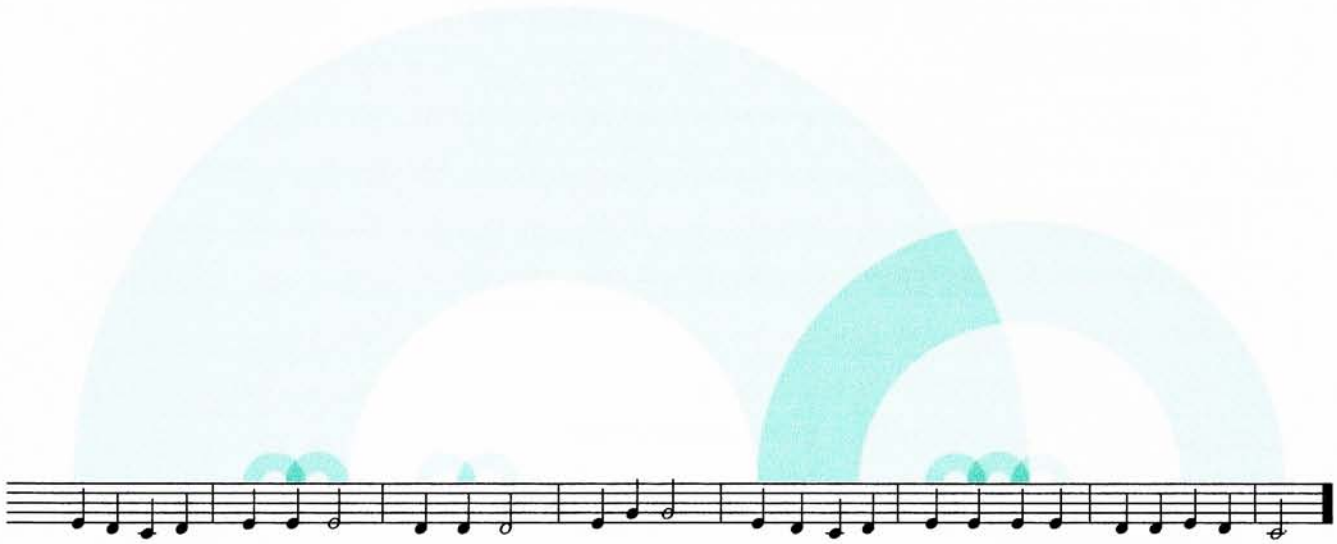
The Power of Limits
Gyorgy Doczi
Shambhala,
1981
p 8



Matching diagrams are based on the fact that sequences often represent a hierarchy of ideas. Melodies, for instance, are usually based on combinations of smaller repeated musical passages; text has repeated words and phrases.

Matching diagrams provide a way to see structure in music. As can be seen in Figure 2.12, in the first line of *Mary Had a Little Lamb*, each arc connects two matching passages, where a 'match' means they contain the same sequence of pitches or repeated musical passages. The score beneath the arcs is provided to clarify the connection between the visualization and the music.

Figure 2.12
Matching diagram
www.bewitched.com/match/index.html
Martin Wattenberg,
1999



The Figure 2.13 diagram visualizes Beethoven's *Für Elise*, a more complicated musical composition than the one above. Matches are based on equality of pitch; where harmonies occur we consider only the top note. In spite of this extremely limited definition of musical similarity, the resulting matching diagram reveals an intricate and beautiful structure.

The matching diagram renders the repeated musical passages at a glance and makes it easier to understand the music with repeated section. This precedent work of matching diagram suggested the idea of expressing the repeated sections of a musical composition.

Figure 2.13
Matching diagram
www.bewitched.com/match/index.html
Martin Wattenberg,
1999

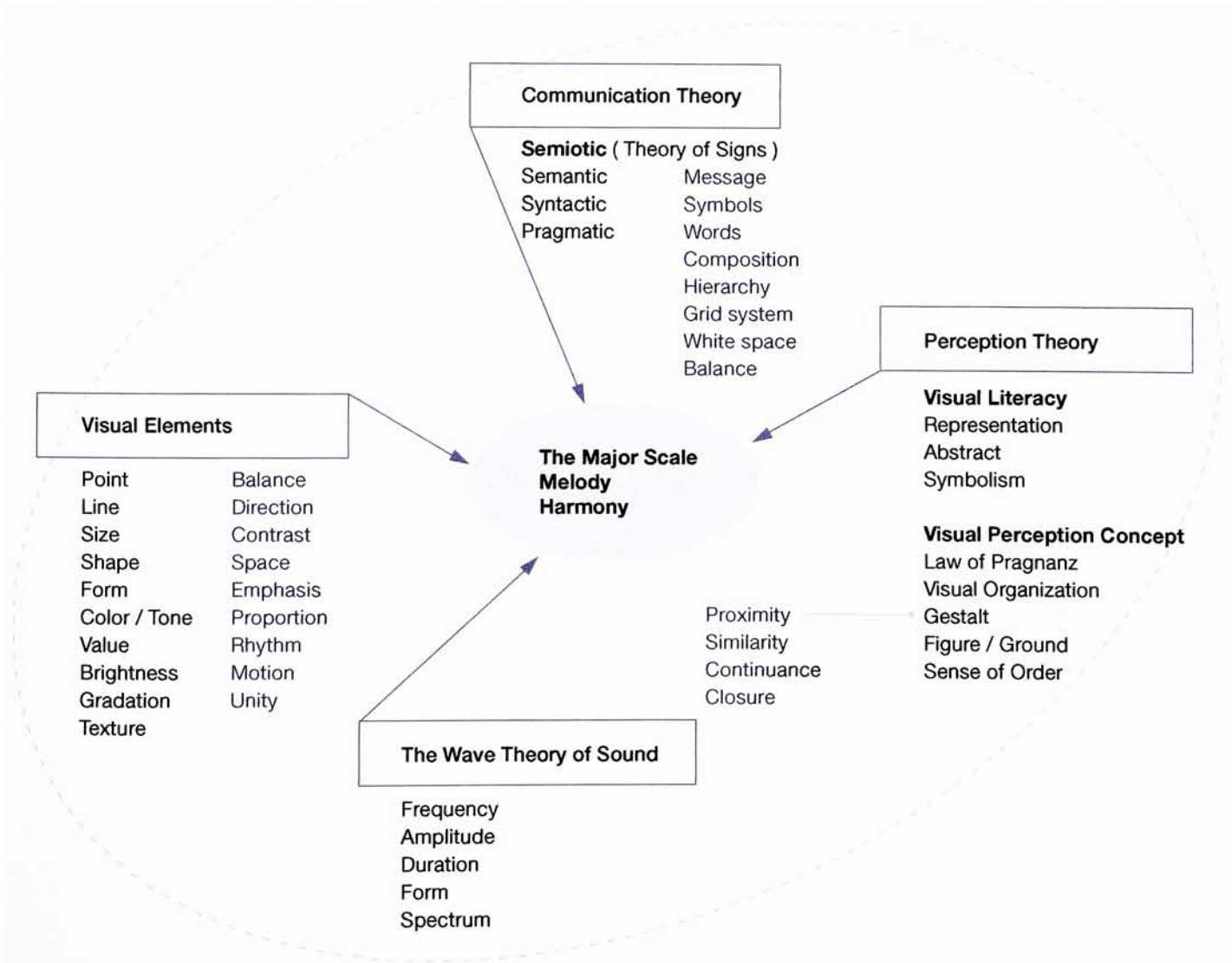
Organizational Diagram

This thesis synthesis combines information, facts and materials into a unified problem statement to further guide research and investigation. This diagram was constructed to determine the most effective organizational structure for communicating the collected research.

Communication Theory, Visual Elements, Wave Theory of Sound and Perception Theory are used to express the major scale, melody and harmony of music. First, as described earlier, Communication Theory (Semiotic Approach) was used to synthesize the elements of each semantic, syntactic and pragmatic dimension. Among them, *Message, Symbols, Words, Composition, Hierarchy, Grid system, White Space* and *Balance* are chosen to be applied in concept sketches.

Second, Visual Elements such as *point, line, size, shape, form, color/tone, value, brightness* and *gradation* are used to effectively and easily express a musical composition in a visual form. Also, the Wave Theory of Sound is used to assign the color of a spectrum to each key according to the frequency of individual key.

Last, Perception Theory is used to help children's perception of this visual expression of music. These theories are synthesized and developed into concept sketches.

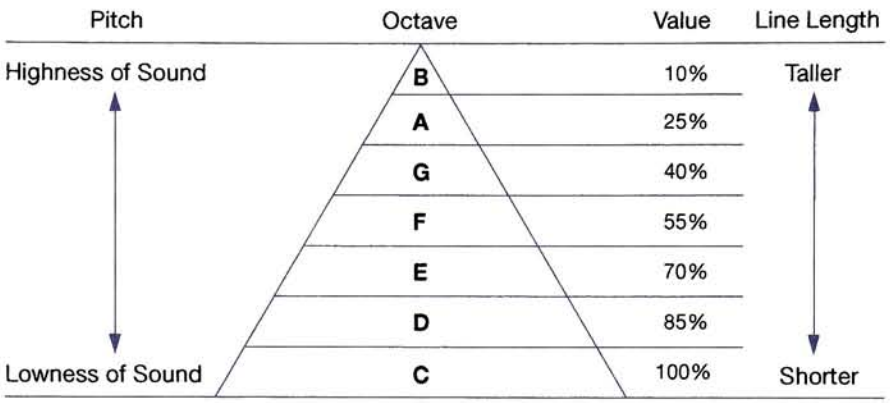


Pitch Analysis

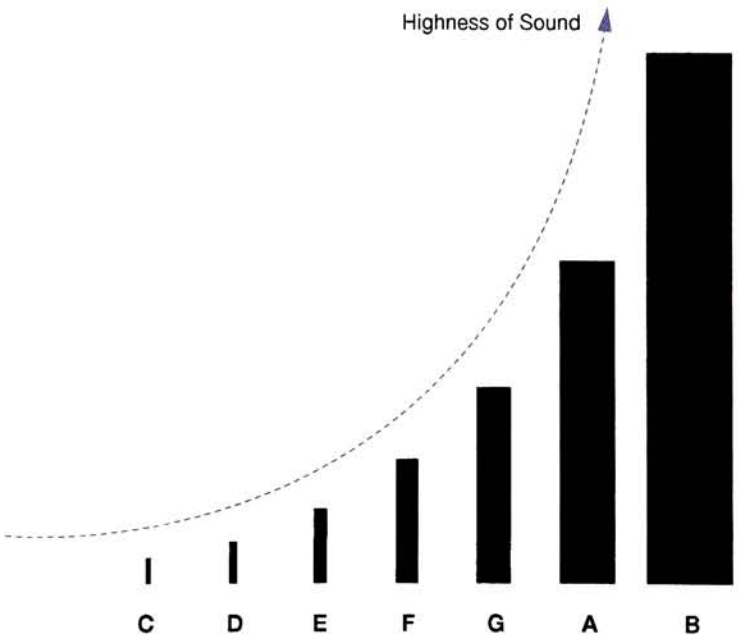
The analysis below shows a representative major scale with pitch, octave, value and line length. Pitch shows the highness and lowness of sound; value is expressed by percentage of one selected color to express the gradation according to the keys in an octave; and the length of each line becomes taller as the sound goes higher in pitch.

These concept sketches were developed based on the organizational diagram. (see page 21) Prior to the ideation of major scale, pitches are analyzed by value of color or line length.

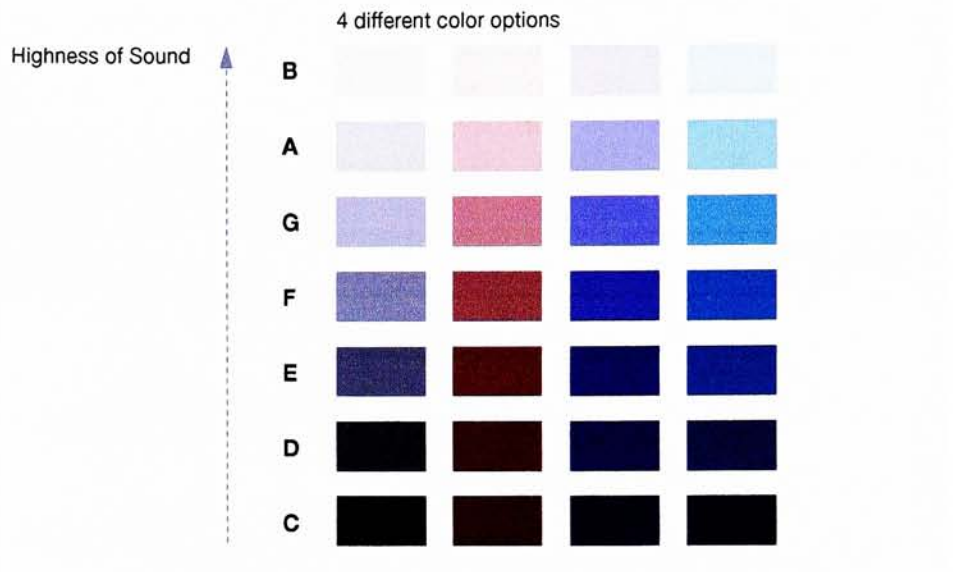
Concept Sketches
Phase 1



Concept Sketches
Phase 2

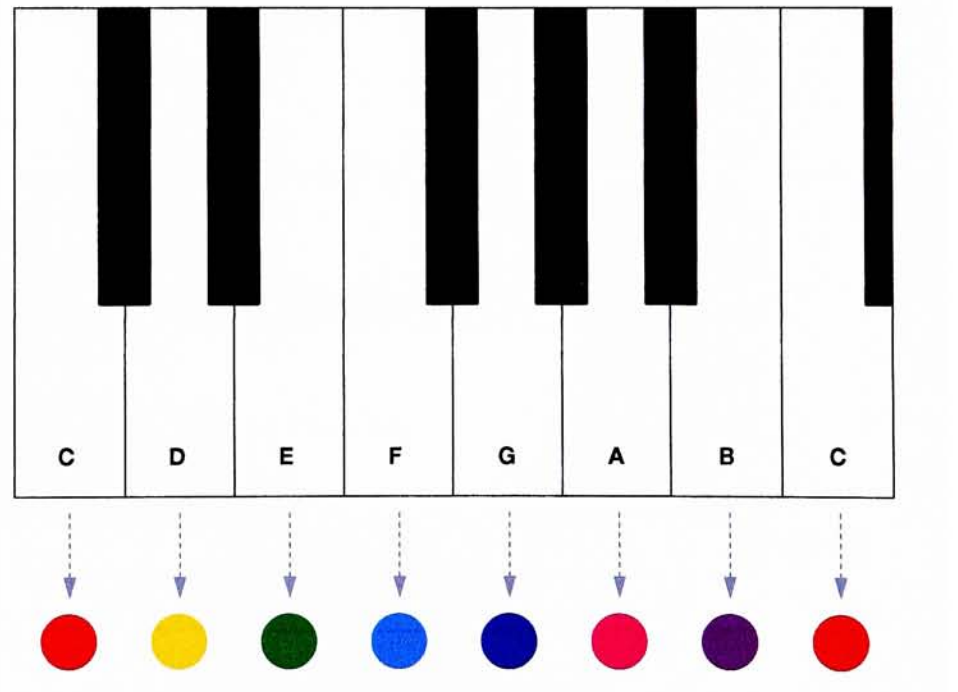


Concept Sketches
Phase 3



This sketch shows each key in an octave on a vertical line according to the highness of sound. Value corresponds to pitch. The higher the sound, the lighter the value. The lower the sound, the darker the value.

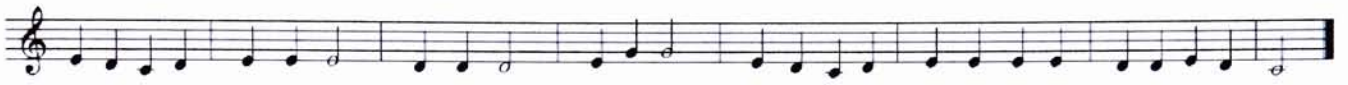
Concept Sketches
Phase 4



This sketch has different color-coding from the above gradation ideation. This has rainbow colors according to the wave theory of sound, and they are matched with each key in an octave.

When these two sketches are applied to *Mary Had a Little Lamb*, the visual systems below are formed. This song is used in this thesis because it is one of the popular children's songs based on basic C major scale. Also, it's an easy composition and repetition of melody makes it easier to express the ideas of this thesis.

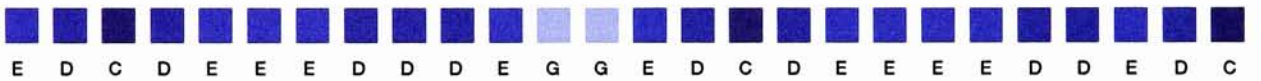
Figure 3.1
Mary Had a Little Lamb
www.bobkwebsite.com/howtoplaymary.pdf



Concept Sketch 1

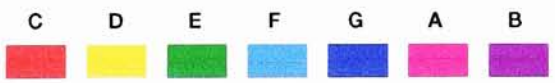
Concept Sketch 1 is the expression of pitch in *Mary Had a Little Lamb* through the gradation of the color Blue.

Mary Had a Little Lamb



Concept Sketch 2

Concept Sketch 2 is the expression of pitch in *Mary Had a Little Lamb* through different color-coding.



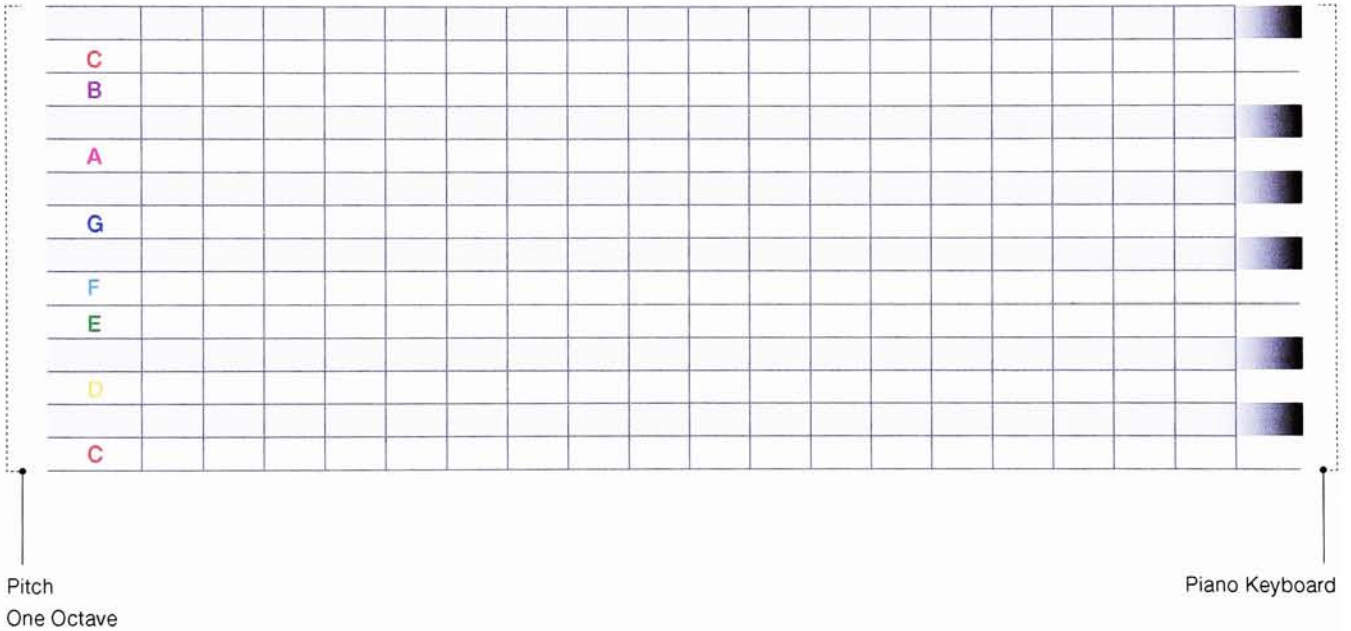
Mary Had a Little Lamb

Grid System

The grid system is used to provide a structure for the major scale and sequence of melody. The grid system below is derived by the keyboard of a piano. The left most column shows the alphabetical names of each piano key and each matching color, arranged with the lowest pitched key at the bottom and increasing in pitch toward the top. Also, the horizontal side of this grid system shows the time or beat of the music and each horizontal space in a small square means one beat. This grid system is useful because it has wider vertical spaces than the regular music sheet and it can also express several octaves by building more grid cells on top of one octave.

Additionally, it shows the black keys of the actual piano as grey colored grids so that the separate signs of sharp (higher in pitch by a half step) and flat (lower in pitch by a half step) are not necessary. Therefore, this helps children better understand and makes it possible to learn the musical composition at a glance.

Concept Sketch 3

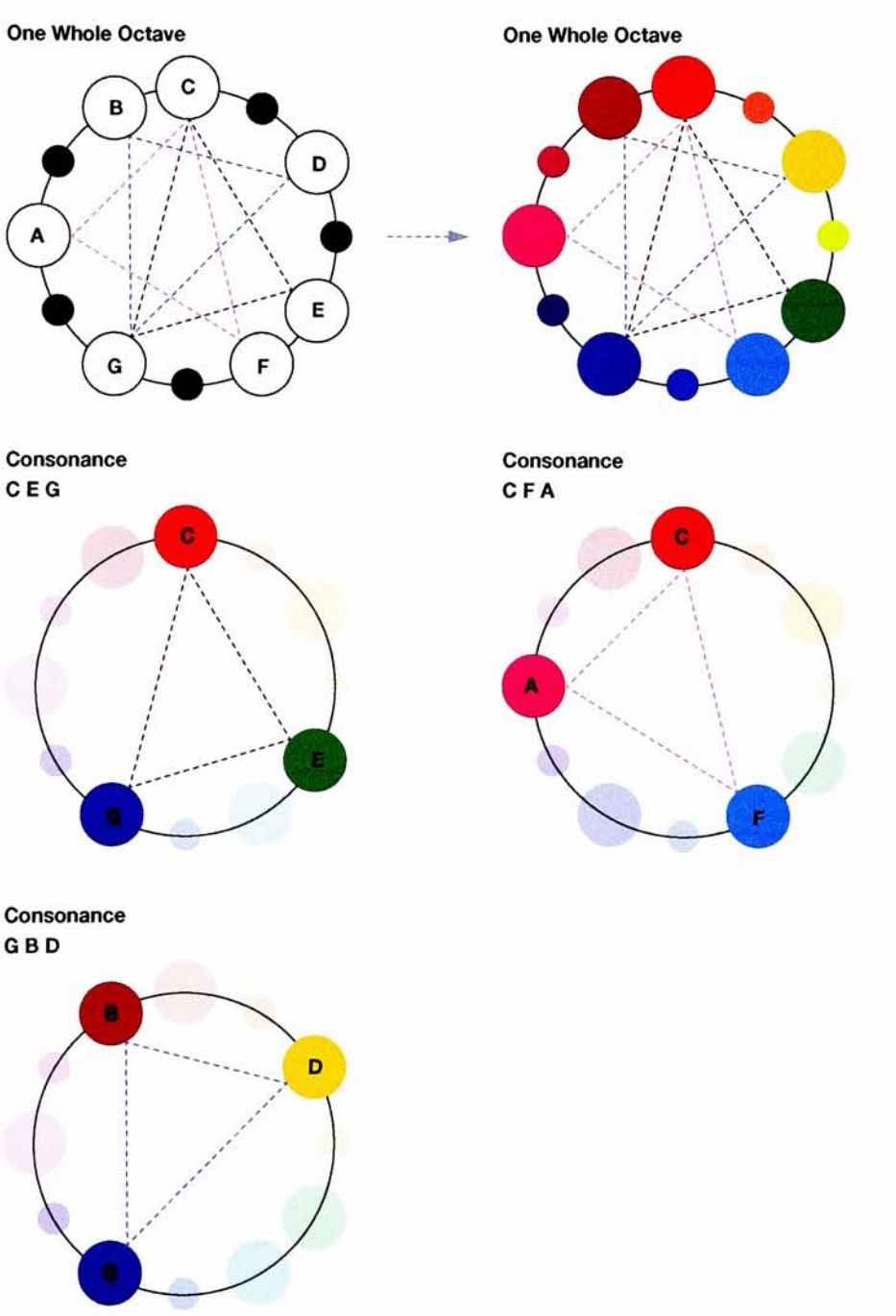


The three harmonies of C major (CEG, CFA, GBD) can be expressed using the color-coding shown below. These sketches show the typical consonance (concordant or harmonious combination of pitches that provides a sense of relaxation and stability in music) of C major scale.

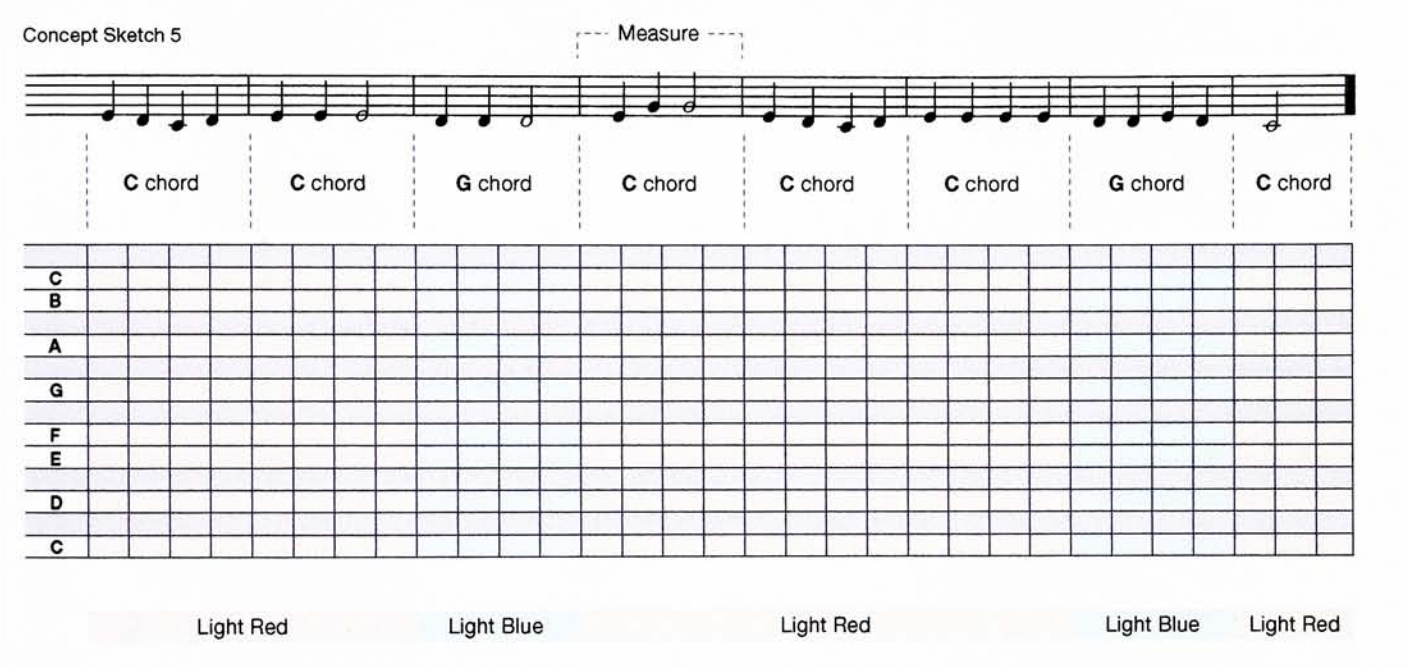
These color wheels show the typical consonances of C major scale (CEG, CFA, GBD) by using a matching color for each key. For example, consonance CEG used red, green and blue color, matching the C, E and G keys.

In addition to the color-coding system of C, D, E, F, G, A, and B keys, the second wheel has the specific color-coding in smaller circles for the sharp (higher in pitch by a half step) and flat (lower in pitch by a half step).

Concept Sketch 4



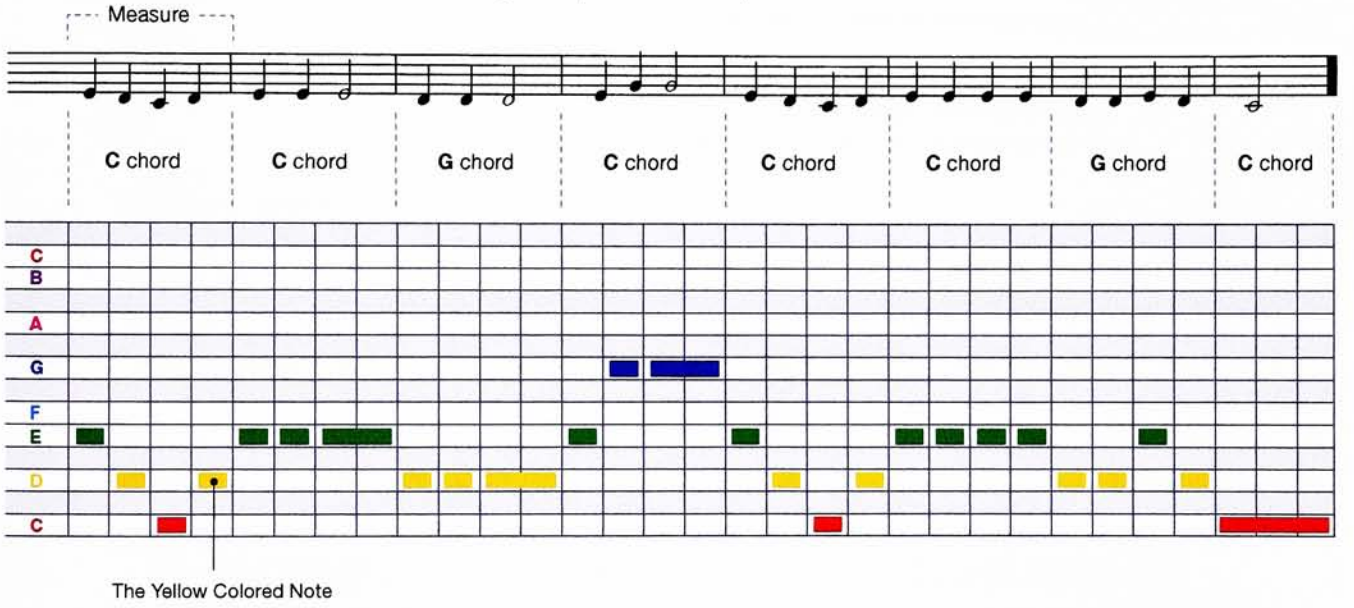
Mary Had a Little Lamb is composed of a repeated C chord (CEG) and a G chord (GBD). A chord means a combination of three or more notes that blend harmoniously when sounded together. To understand the repetition and formation of these harmonies, the red color and the blue color are overlapped on the grid system according to the harmony of each measure (A bar or a measure is a segment of time defined as a given number of beats of a given duration in music notation. Usually, a measure is expressed by vertical bar lines). Light red is matched for the C chord and light blue is matched for the G chord.



Combination 1

Concept Sketches 2, 3 and 4 are combined to visualize the song, *Mary Had a Little Lamb*. Specifically, the color-coding system in Concept Sketch 2, the alphabetical names of major scale in a grid system in Concept Sketch 3 and the consonance color wheels in Concept Sketch 4 are properly united to visually express the song.

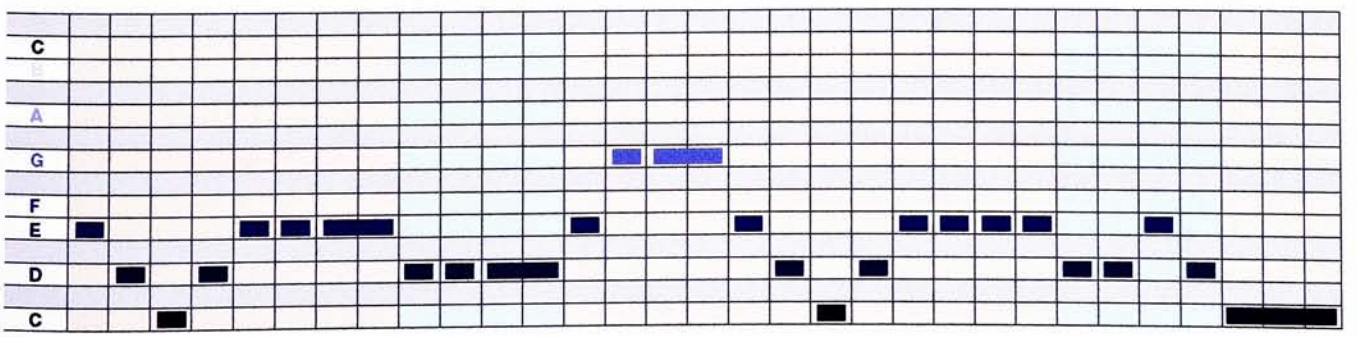
The matching color of each pitch and the grid system of major scale are used below. Also, the consonances or chords of this song are expressed through the used of the green, yellow, red and blue colors. For example, the first measure in the song consists of the C chord (CEG) because of its green and red colored notes. Even though the measure has yellow colored notes, the blue colored notes are well matched with the C chord harmony. Therefore, this whole measure is determined to have the C chord as its main harmony. The chords of the whole song are expressed as a repetition of C-C-G-C chords.



Combination 2

Concept Sketches 1, 3, and 5 are combined to visualize the song, *Mary Had a Little Lamb*. Specifically, the gradation system in Concept Sketch 1, the grid system in Concept Sketch 3 and the red and blue pattern system in Concept Sketch 5 are effectively united to express the song in a visual system.

Each pitch of the song is expressed by the gradation of the blue color in a grid system. Also, the repetition of the C-C-G-C chords of the song is expressed here by the red and blue pattern on the grid system.



Combination 3

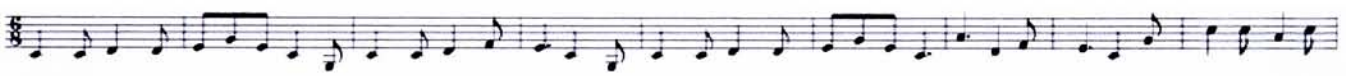
Pop Goes the Weasel is a song with pitches above and below the tonic and it is used in this thesis to express the same color-coding of the same note.
For example, the color of the C note in the tonic below is red and the color of the C note in the tonic above is also red. This shows that this visual system can be used appropriately in other songs as well.

As can be seen in the sketch below, the more complex visual system of a musical composition can be expressed because this song consists of eighth-notes and quarter-notes (see Figure 2.7).

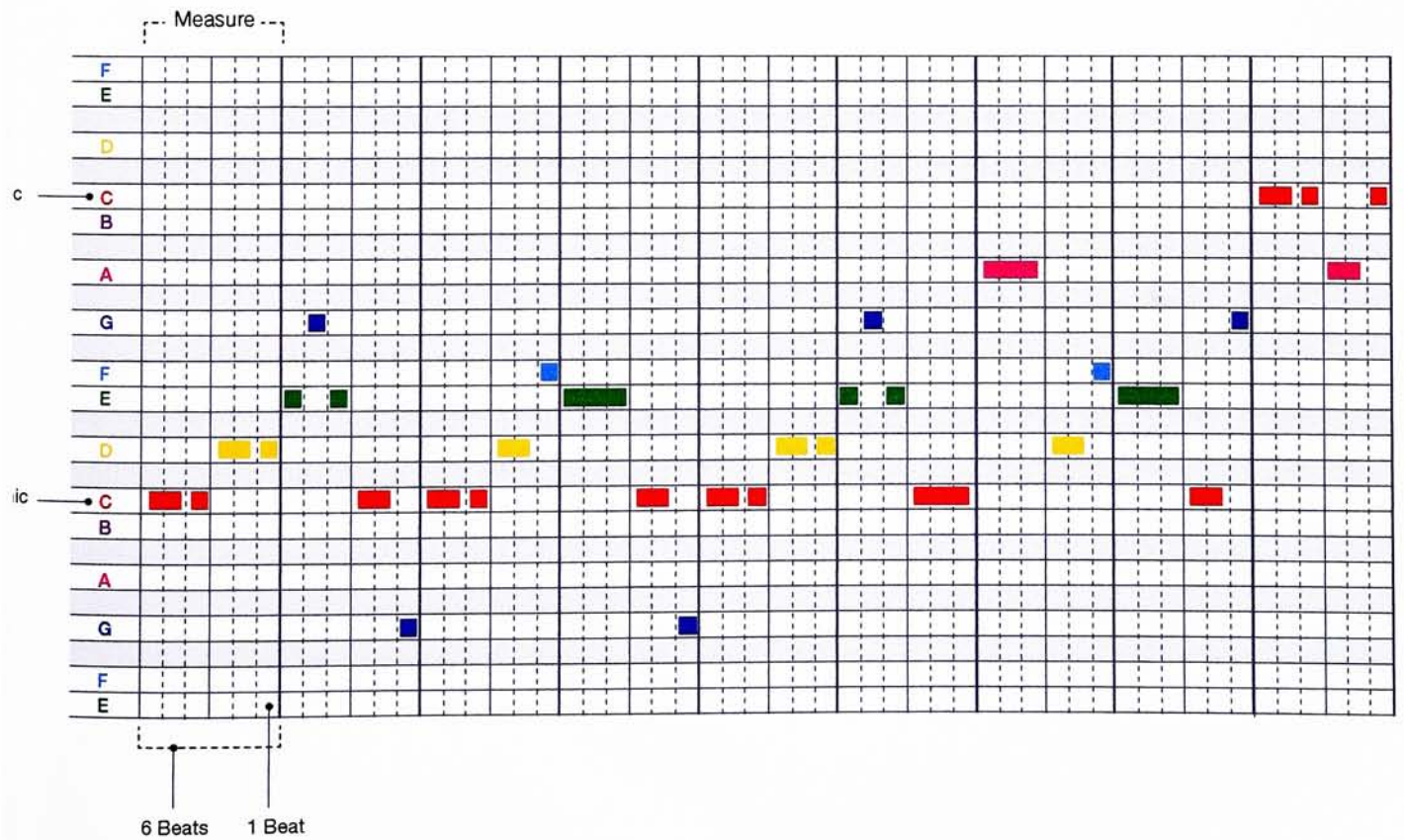
Pop Goes the Weasel is a six-eight meter song. (six-eight meter, known as six-eight time, refers to a musical meter characterised by a primary division of 6 beats to the measure) Therefore, this grid system has bold linear bars to express each measure containing 6 beats. The non-bold, solid vertical lines are for 3 beats and the vertical dotted lines are for 1 beat which expresses the eighth-notes of the song.

As can be seen below, the horizontal length of the colored box represents the beat of each note. For example, the shortest box divided by the dotted line is for the eighth-note of the song.

Figure 3.2
Pop Goes the Weasel
http://sniff.numachi.com/~rickheit/dtrad/pages/tiPOPWEAS2;ttWEASLPOP.html



Round and round the cobbler's bench the monkey chased the weasel, the monkey thought 'twas all in fun. Pop! Goes the weasel. A penny for a



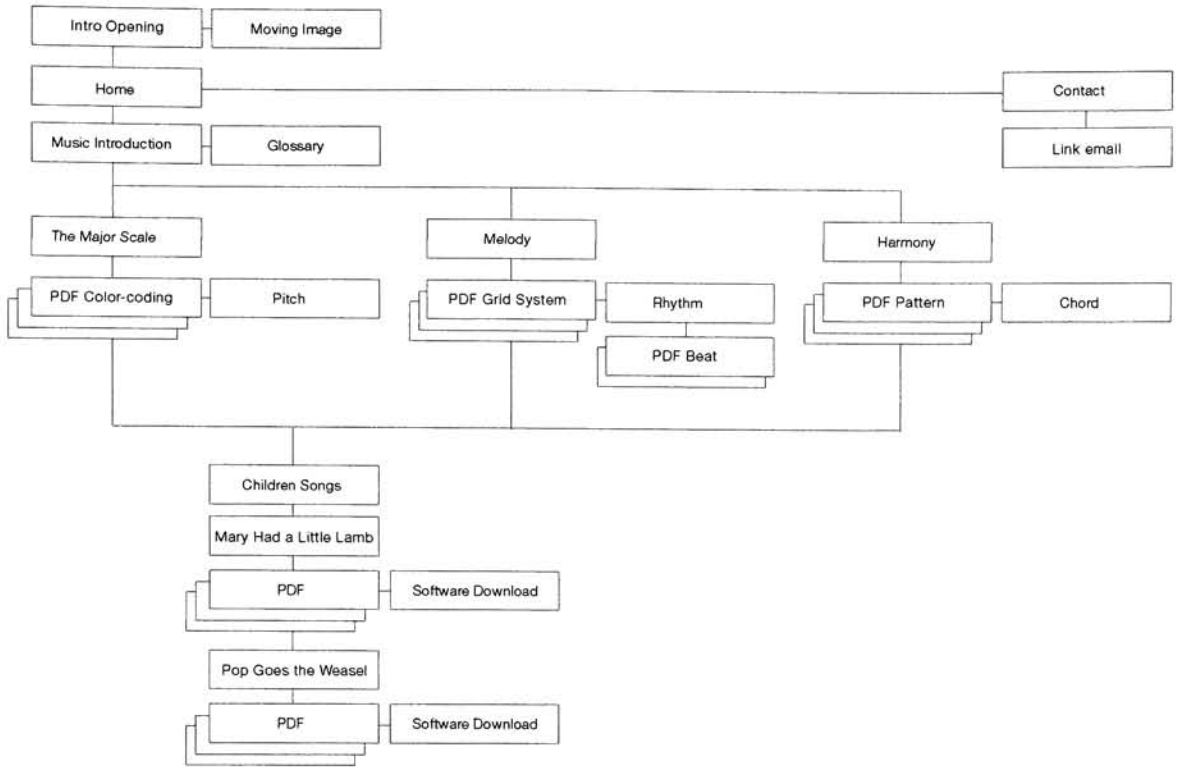
Ideation

The goal of this ideation is to render a wide range of possible solutions for the application. The ideation describes and shows examples of the generation of conceptual solutions. It also shows the preparation of a range of preliminary design approaches. The ideation is organized into the following categories:

Navigation Map
The Navigation map is developed to provide a more convenient search for users of this computer-generated website, which is the final application of this thesis. The hierarchy of the map is divided into nine main navigational areas such as *Home, The Major Scale, Melody, Rhythm, Harmony, Glossary, PDF, Contact* and *Sitemap*. Additionally, through the ideation of navigation map, which is another navigational area, this thesis candidate developed a the system for this website.

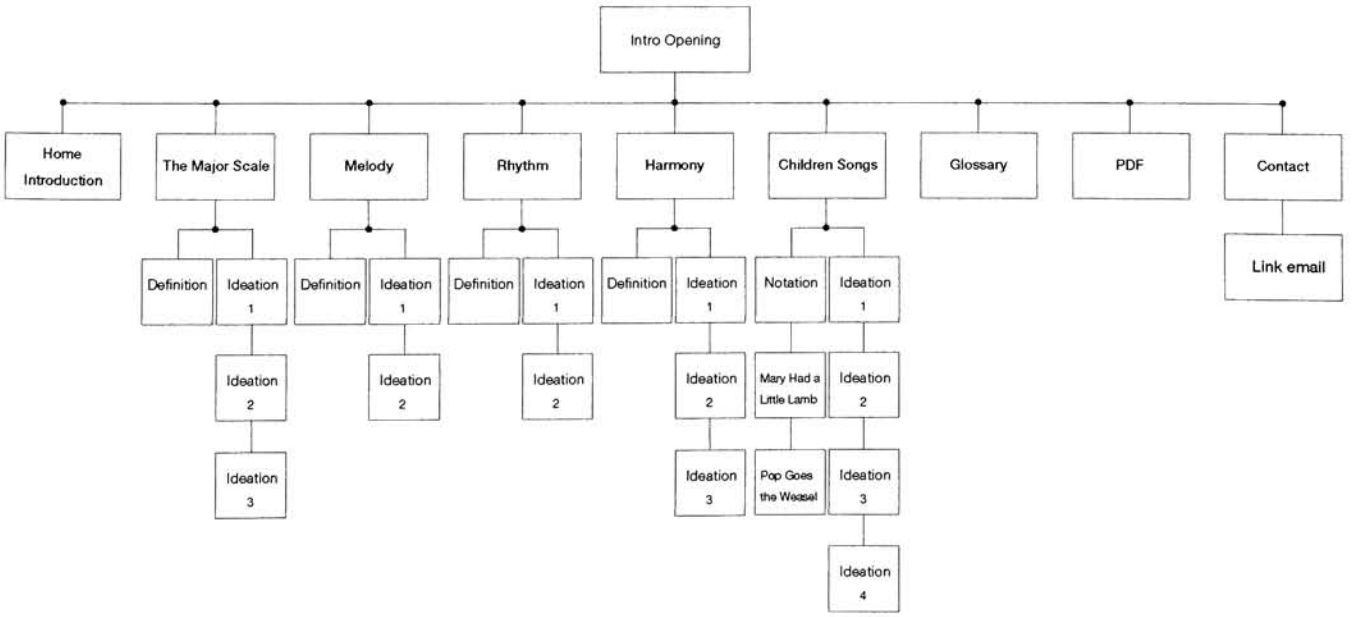
Screen Shot
A screen shot is a single image captured in a website. Screen shots are based on navigation maps and evolve through several sketches and feedback from the thesis committee to develop more accessible previews for users.

Navigational Map
Phase 1



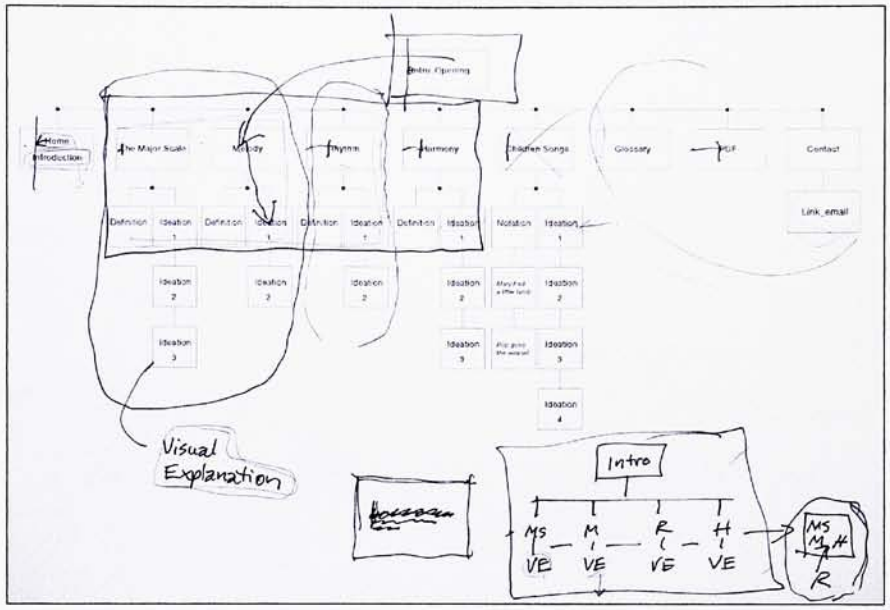
Navigational Map
Phase 2

The hierarchy of the map is divided into ten main navigational areas to enhance the interaction of Navigational Map Phase 1. However, for improved communication, Navigational Map Phase 3 is developed.



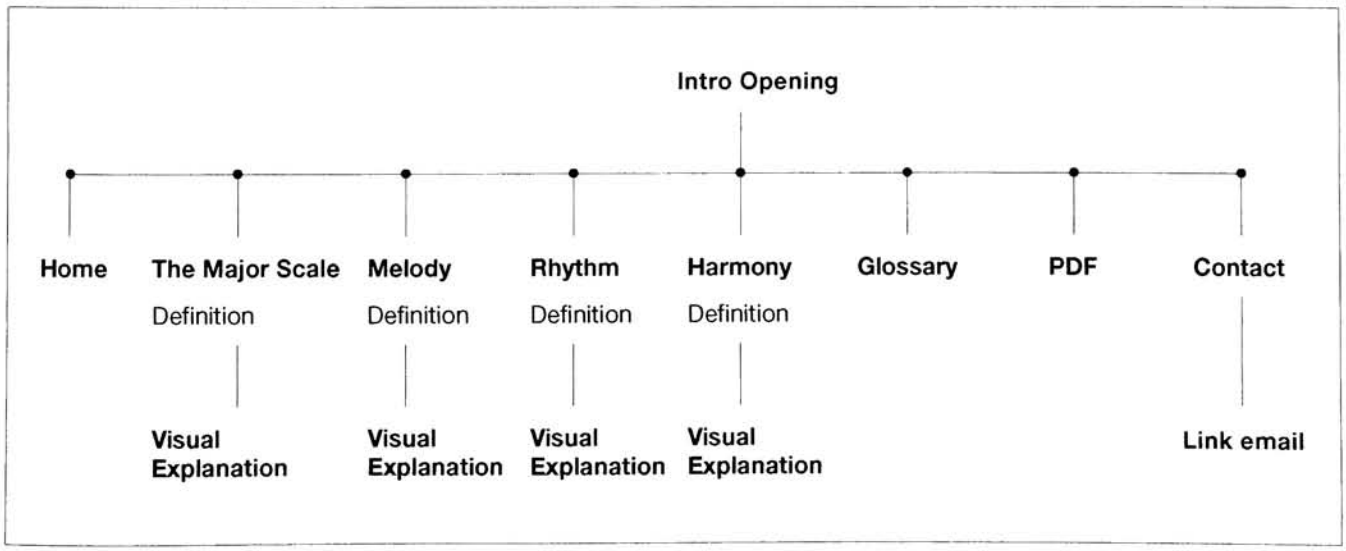
Feedback
Navigational Map
Phase 2

Through feedback from chief advisor Bruce Ian Meader, Phase 2 is incorporated into Phase 3. The reason Phase 2 is modified is due to the complexity of the contents. The term *Ideation* was changed to *Visual Explanation* because it is a more accurate and descriptive title. One individual *Visual Explanation* replaced several ideation components because one example was less confusing and more effective than several examples.



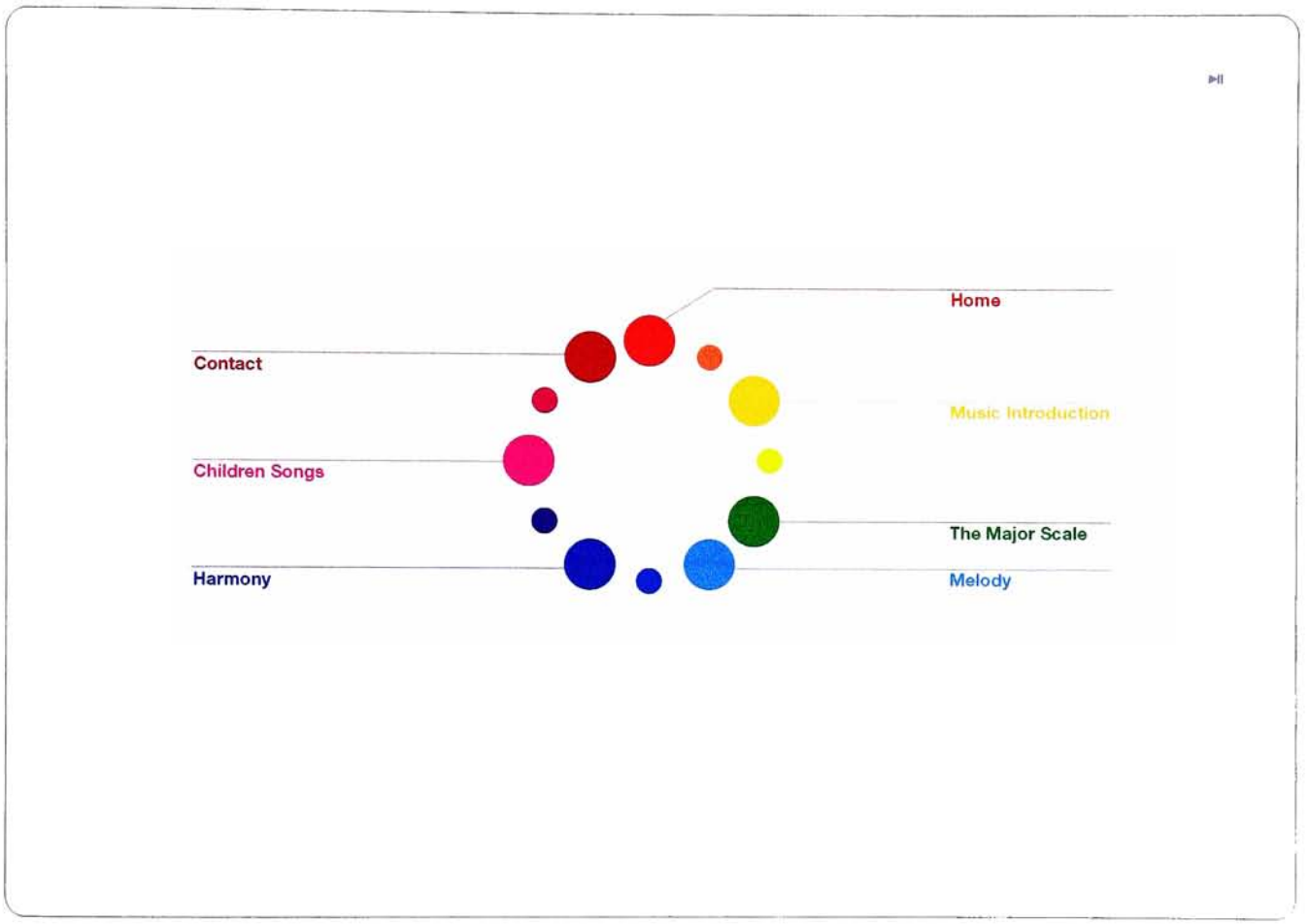
Navigational Map
Phase 3

Children Songs section of Phase 2 is deleted from the Navigation Map because the *Children Songs* section is used to express *Visual Explanations* of *Major Scale, Melody, Rhythm* and *Harmony.*



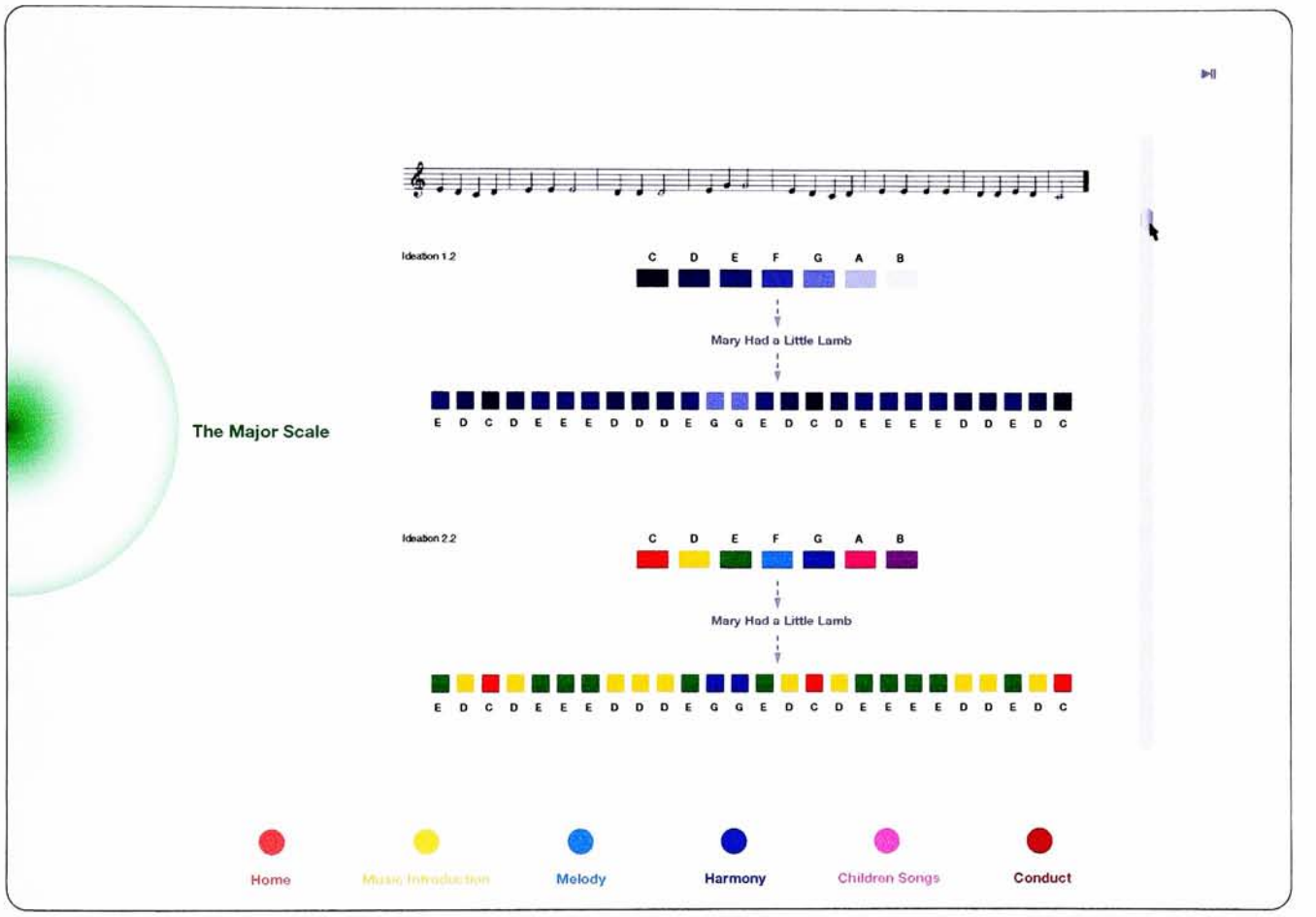
Screen Shot
Concept Sketches
Phase 1

This first page of the website shows each navigational area using the color wheel, which was developed in the Synthesis section. When users click each large circle, an overall explanation of each section appears with visual examples. For instance, if users click *The Major Scale*, the screen shot of Phase 2 is shown.



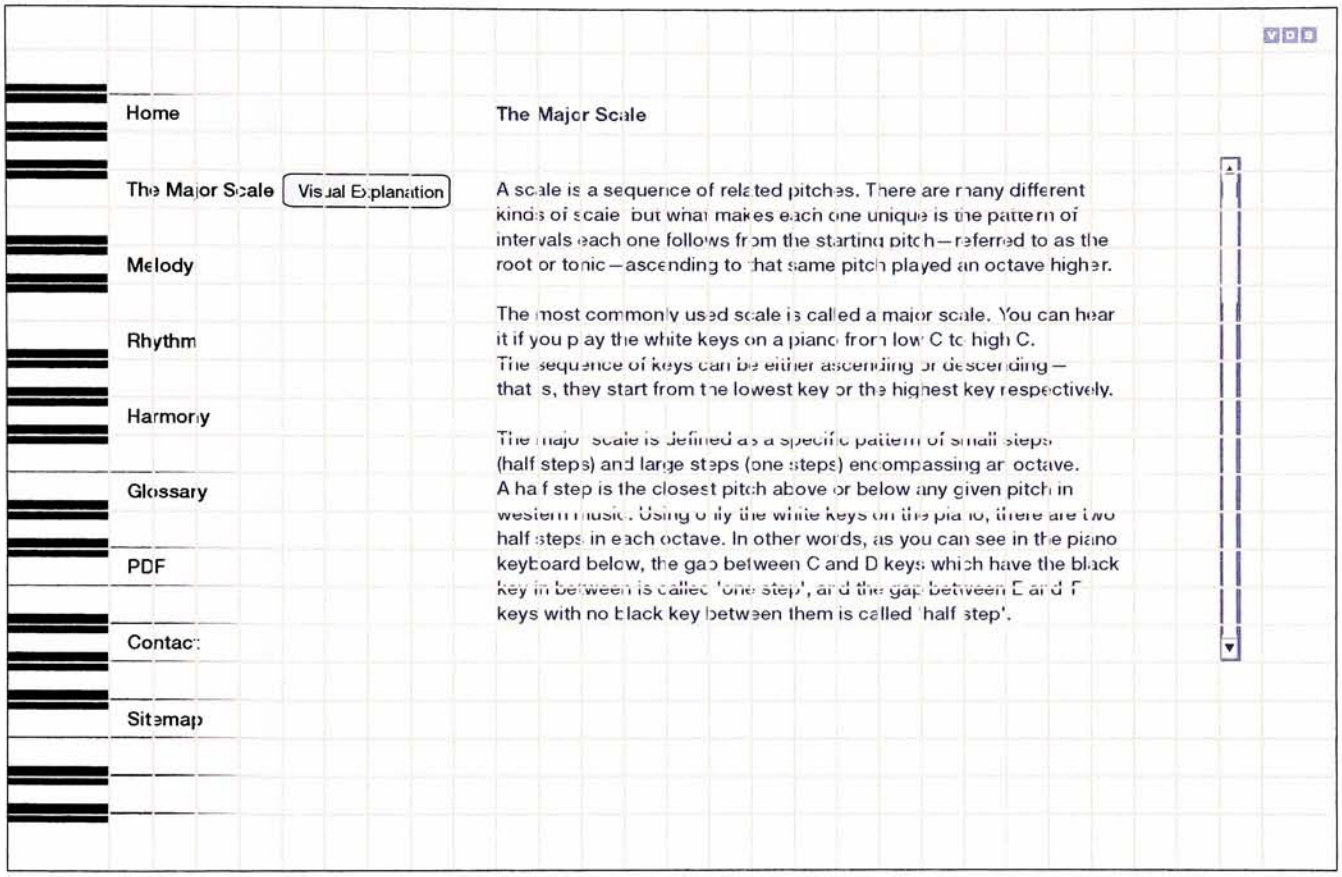
Screen Shot
Concept Sketches
Phase 2

This Concept Sketch shows a visual explanation and definition of Major Scale. Users can navigate to the desired section using the circle button below.



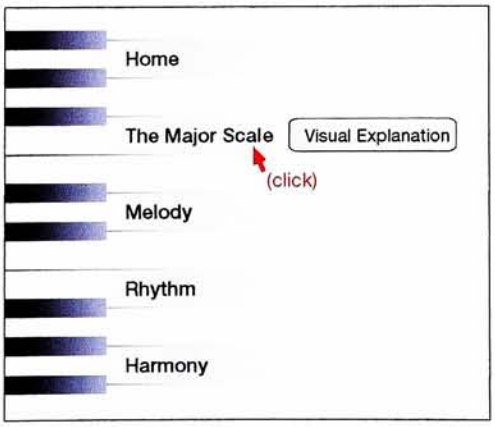
Screen Shot
Concept Sketches
Phase 3

This screen shot uses the hierarchical grid system to display the nine areas of Navigation map (*Home, The Major Scale, Melody, Rhythm, Harmony, Glossary, PDF, Contact* and *Sitemap*). The grid system is based on a keyboard of a piano which is located on the left side of the webpage.



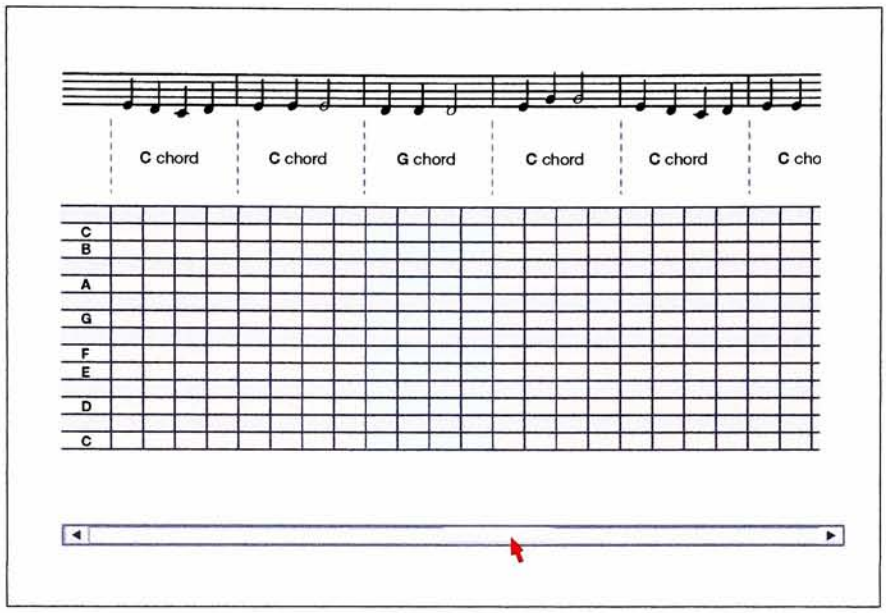
Screen Shot
Concept Sketches
Phase 4

If users click *The Major Scale, Melody, Rhythm* or *Harmony*, the definition of each term appears on the website and the Visual Explanation button appears on the right side. When the button is clicked, each visual example is presented.



Screen Shot
Concept Sketches
Phase 3

A scroll is used to display a significant amount of information in a limited space without changing the webpage. The information of each navigational area can be shown in one glance using the scroll bar below.



Typeface

Helvetica is a typeface designed by Max Miedinger in 1957 for the Haas'sche Schriftgiesserei type foundry of Switzerland and in 1983, Linotype released the Helvetica Neue typeface, based on the original Helvetica. This typeface is highly legible. The Helvetica Neue 55 Roman was chosen for the body text and 75 Bold was chosen for the main text of the Screen Shot.

Helvetica Neue
55 Roman

Helvetica Neue
75 Bold

Intermediate Evaluation

Included as part of the intermediate evaluation are conversations, meetings and presentations with students and professors. It was their feedback that helped shape and develop the project, and the presentation for the thesis show.

Progress Presentation

This presentation was given to graphic design graduate students and professors on February 8, 2005. The presentation included visuals using the PDF format and brief overview of the entire project thus far. The research collected on music theory, as well as some conceptual sketches for the thesis design application were included in this presentation. The presentation was explained as follows:

- What the graphic design problem aims to solve, develop and expand
- Outside content of the thesis
- Goals of the thesis
- What the thesis research methods are, and how this thesis has synthesized this information
- Summarize the ideation process and present the application progress thus far
- What preliminary evaluation the thesis has planned, and the anticipated remaining thesis tasks

Feedback was provided during and after the presentation, in the form of questions, comments and discussion of the concept sketches which visualized the song, *Mary Had A Little Lamb*. This thesis candidate received an overall evaluation on issues of organizing the thesis, and in response to each concept sketch.

Committee Meetings

Committee meetings were held periodically with chief advisor Bruce Ian Meader and Associate Professors Peter Byrne and Michael E. Ruhling at Rochester Institute of Technology. Each meeting was an opportunity to discuss progress, answer and ask questions, receive feedback, and consider next steps. These meetings were held for evaluation throughout the project on an individual basis. Weekly meetings with the chief advisor provided more specific feedback and direction as the thesis progressed.

The first committee meeting was on November 15, 2005. The main focus of the meeting was directed toward understanding the thesis proposal and the plans for accomplishment. The thesis proposal and documentation structure was reviewed and evaluated for future direction. The concerns were directed toward understanding the audience and how the thesis would impact that audience.

The second committee meeting was on December 15, 2005. The main focus of this meeting was to examine the research and synthesis process. A secondary focus was on how to develop the Ideation section.

Intermediate Evaluation

The third committee meeting was on January 31, 2006. The main focus of this meeting provided feedback on concept sketches and on effective visual elements to visualize the musical components (major scale, melody and harmony). It was proposed that this thesis candidate try visualizing *Mary Had A Little Lamb* to set an effective example for developing the visual system.

The fourth committee meeting was on April 7, 2006. The Thesis Show Panels in the Bevier Gallery were presented. Thesis committee members were consulted for evaluation and helped identify a potential application. After this discussion, it was suggested that the system visualizing *Mary Had A Little Lamb* include the beat of the music. Also, to apply the visual system of this thesis, *Pop Goes The Weasel* was visualized in the Synthesis section.

The fifth committee meeting was on May 5, 2006. There was an evaluation on the overall organization of the thesis. Also, the final application of the thesis was discussed. To express the melody in detail, the expression of rhythm in *Pop Goes The Weasel* was added in a sketch.

Final Application

The final application for this thesis is a computer-generated website to provide relevant audiences of this thesis with effective ways of teaching music. The final application is the website, which provides the most effective vehicle for presenting the visualization of the major scale, melody and harmony.

For music educators to use this website in their classes, the definition of the musical components and visual examples are provided, and downloading each visual example using the *PDF* option is possible. The visual examples may be used by music educators as a teaching material for children in classes to explain the major scale, melody, rhythm and harmony. Not only can the website be used for the music class, but older children could use it independently.

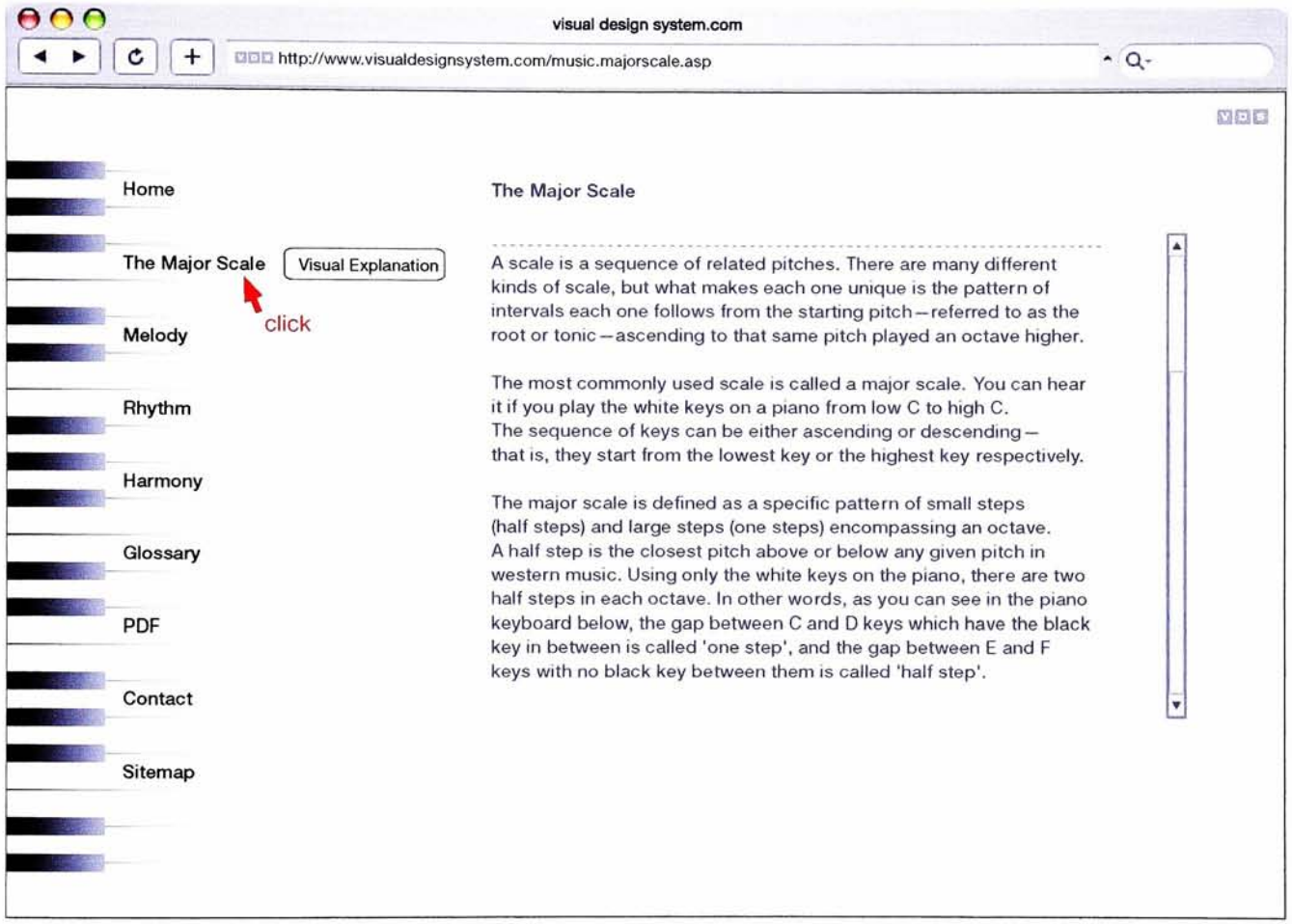
The website is divided into several pages: *Home, The Major Scale, Melody, Rhythm, Harmony, Glossary, PDF, Contact* and *Sitemap*. The starting page of the website, *Home*, provides an introduction and overview.

The Major Scale, Melody, Rhythm and *Harmony* pages are individually divided into *Definition* and *Visual Explanation* parts. The *Glossary* page lists the musical terminology. The *Contact* page has the email address of this thesis candidate. Finally, the *Sitemap* page provides the overall navigation flow chart of the website.

Please refer to the layout of the website on pages 40–44.
In the example provided, the *Major Scale, Melody, Rhythm, Harmony* and *Sitemap* pages are presented.

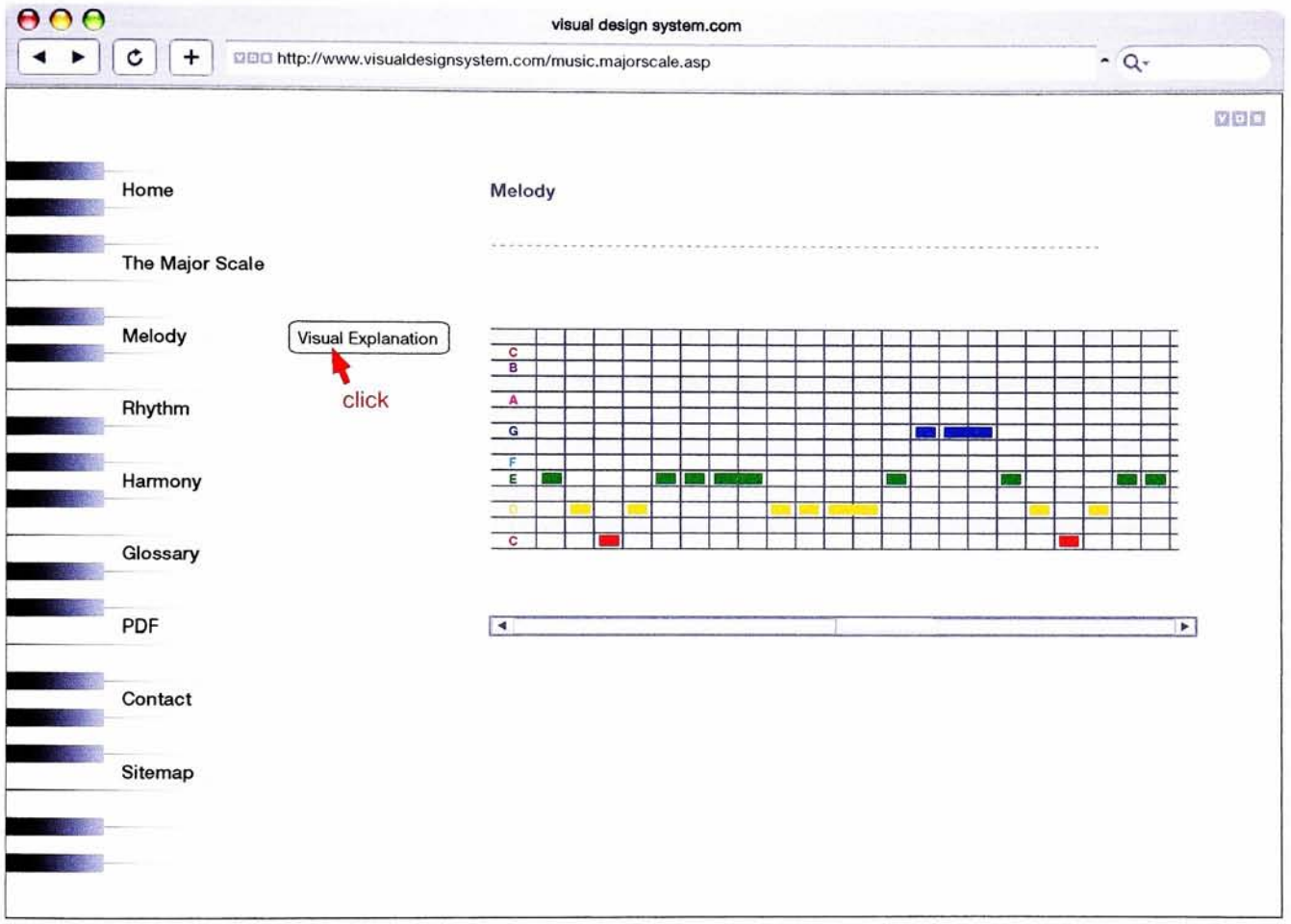
The Major Scale

This application is the *Screen Shot* when *The Major Scale* is chosen, and as can be seen in the example, the definition and *Visual Explanation* buttons appear automatically when The Major Scale is clicked. Users can view the definition at a glance using the scroll bar.



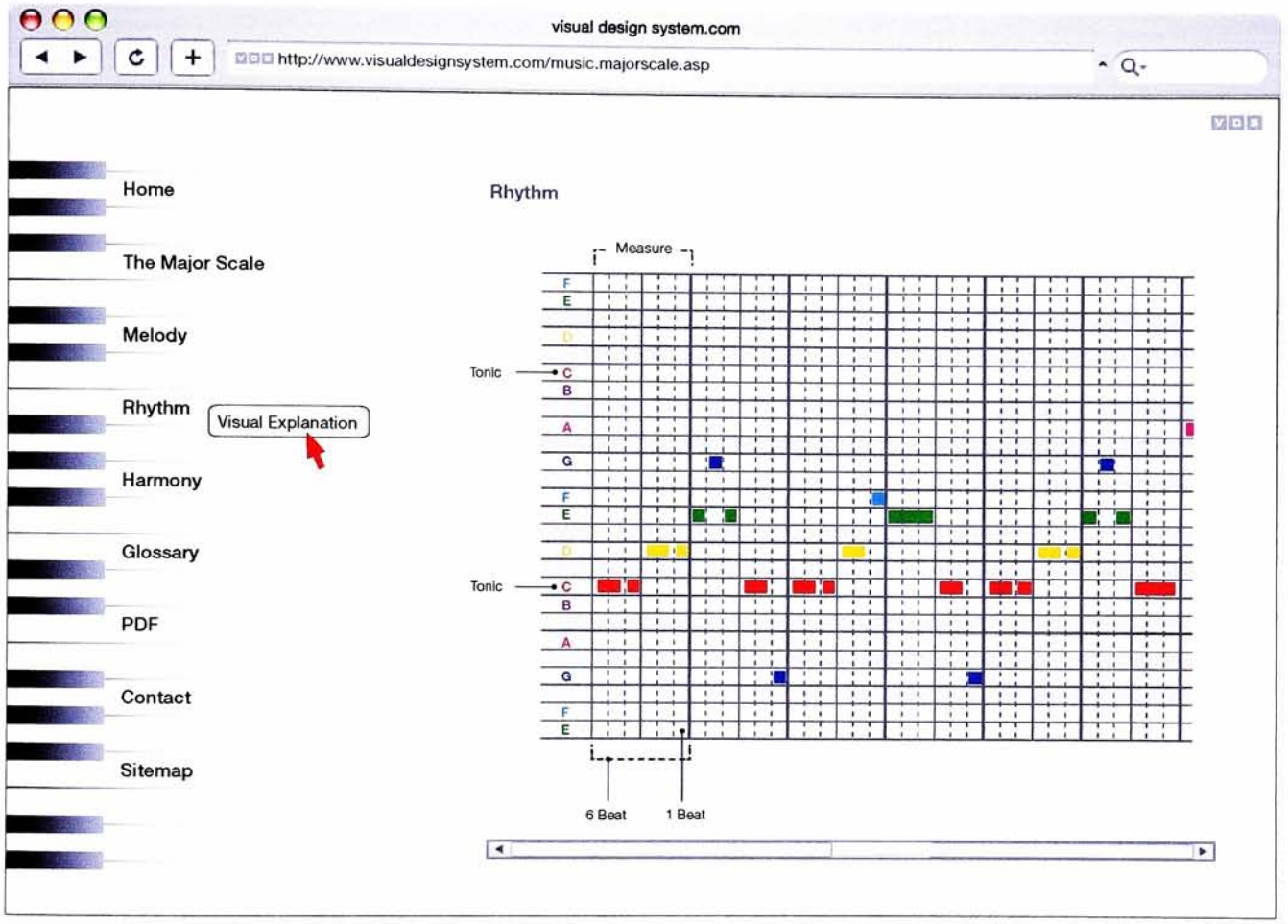
Melody

This application is the *Screen Shot* when *Melody* is chosen, and as can be seen in the example, the visual explanation appears automatically when the *Visual Explanation* button is clicked. Users can view the visual explanation at a glance using the scroll bar.



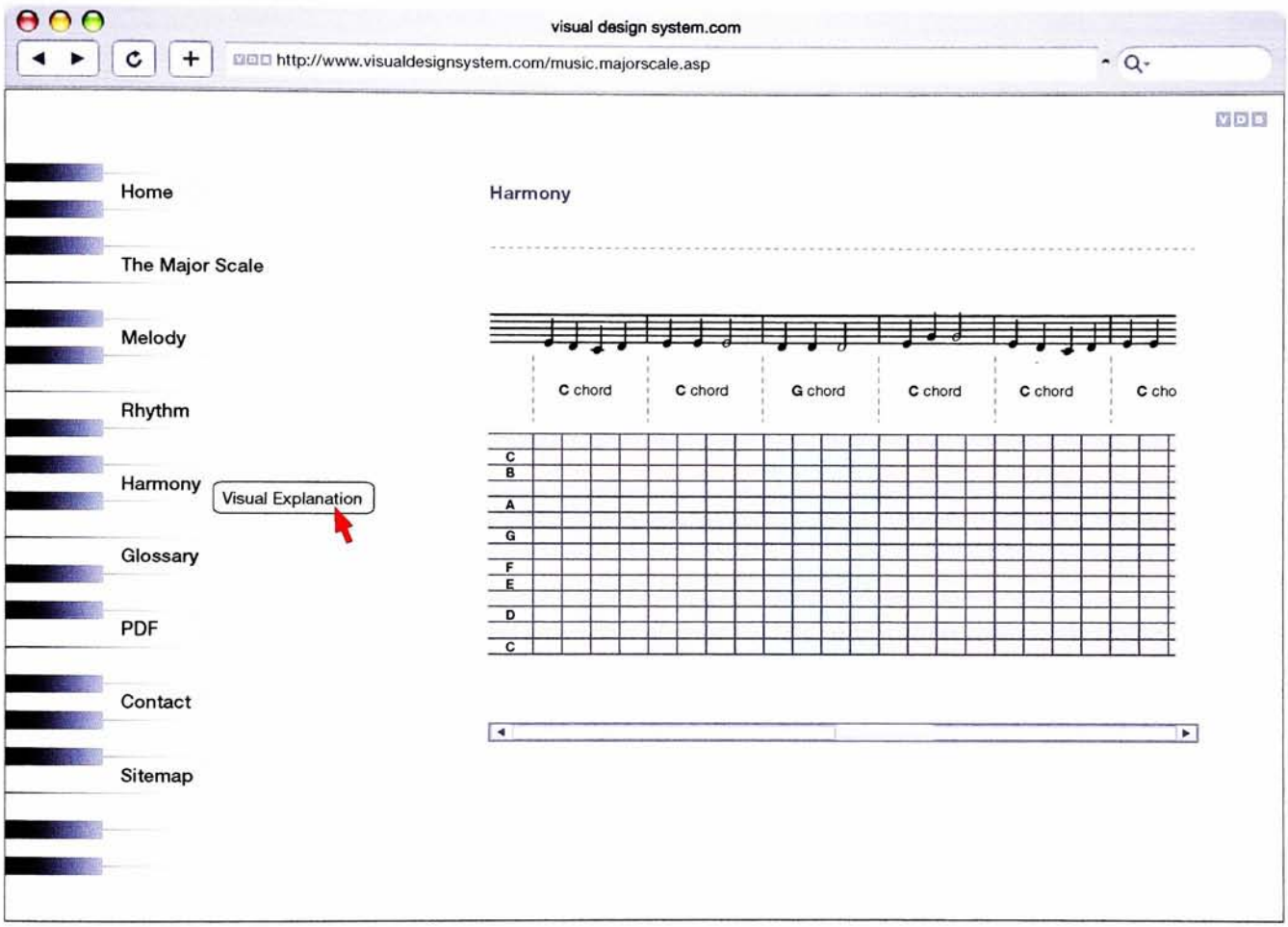
Rhythm

This application is the *Screen Shot* when *Rhythm* is chosen, and as can be seen in the example, the visual explanation appears automatically when the *Visual Explanation* button is clicked. *Pop Goes the Weasel* is used to express the visual explanation of *Rhythm*.



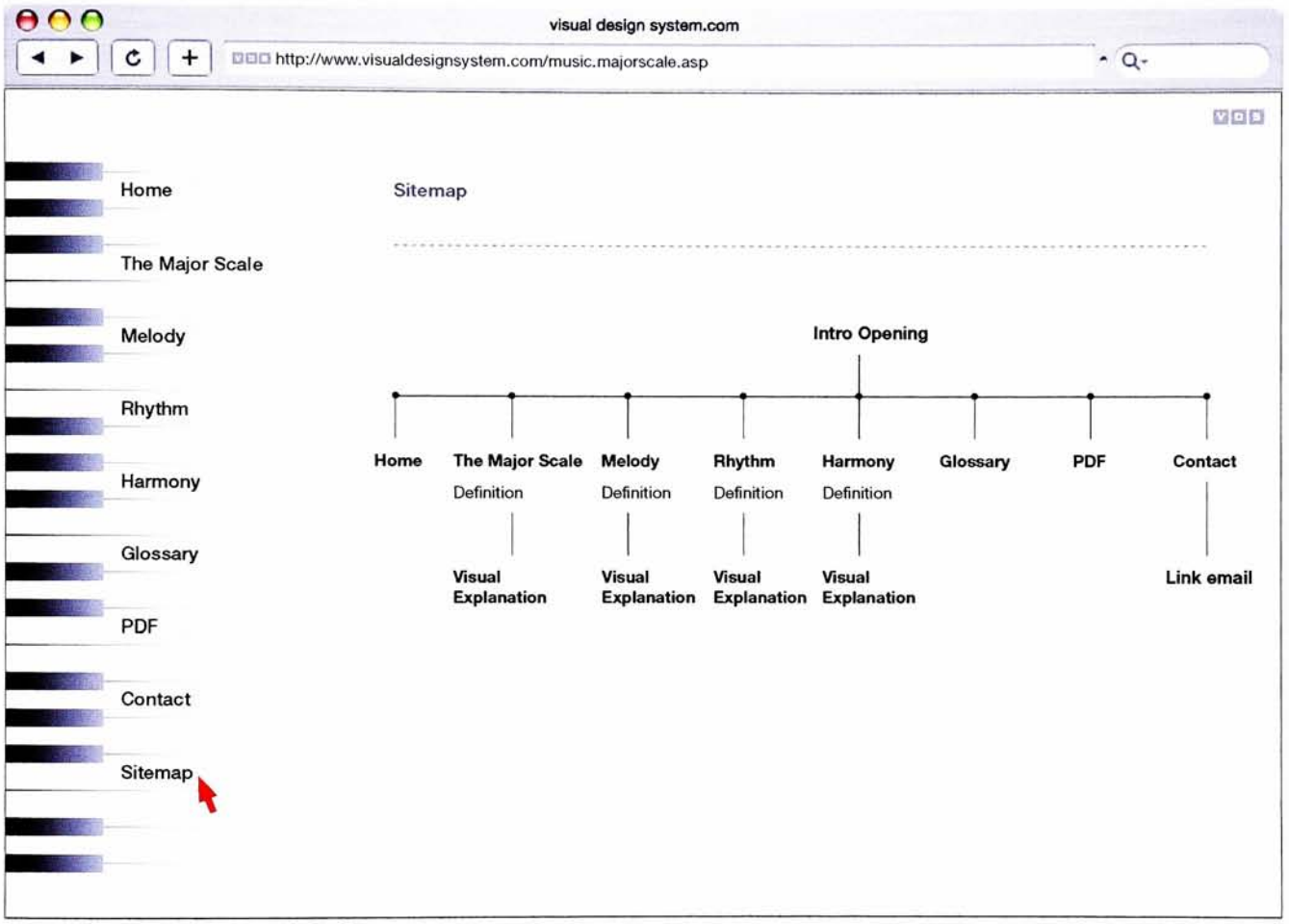
Harmony

This application is the *Screen Shot* when *Harmony* is chosen, and as can be seen in the example, the visual explanation appears automatically when the *Visual Explanation* button is clicked. Users can view the visual explanation at a glance using the scroll bar.



Sitemap

This application is the *Screen Shot* when *Sitemap* is chosen, and as can be seen in the example, the navigational map appears automatically when the *Sitemap* button is clicked. This navigational map is created to provide more convenient search of the website for the users.



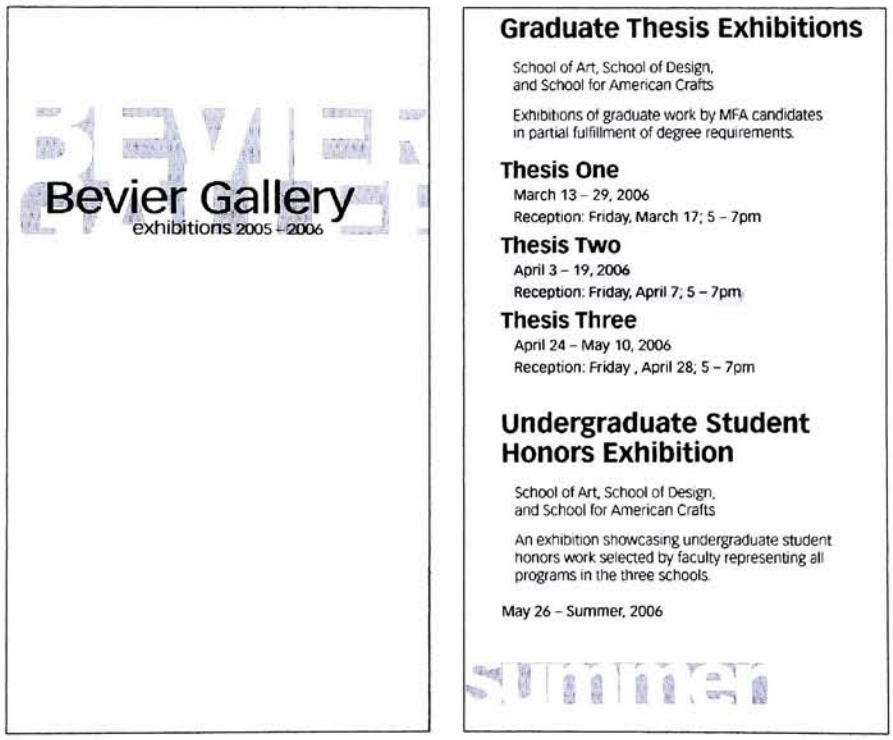
Thesis Gallery Show

The Graduate Graphic Design Thesis Show in the Bevier Gallery at Rochester Institute of Technology was from April 3–19, 2006. This thesis exhibition provided graduate students with an opportunity to show their work to the public.

The installment for the thesis project consisted of four panels describing the overall contents of the thesis. The design of the panels and the information was well received and easily understood. Each thesis display panel measured 34 x 22 *inches,* with a total of four display panels.

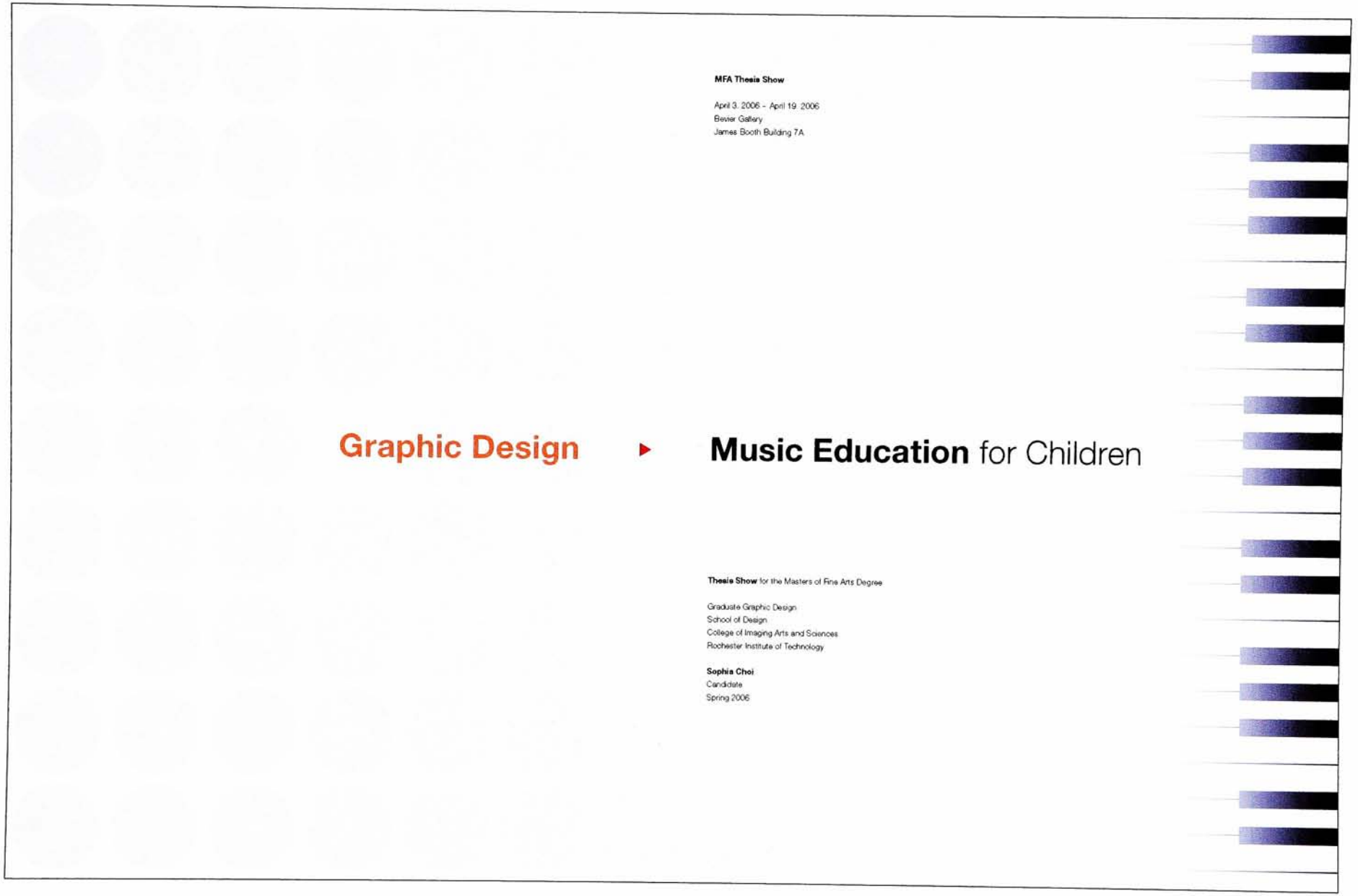
The first panel was the title panel. The second panel described the thesis definition and the research process of graphic design and music. The third panel described the synthesis and ideation. The last panel showed conceptual sketches and described the final application. Please refer to the panels on pages 46–49 in this Dissemination section.

In the future, the application of this thesis may be published in hand books, and they may be distributed to anyone involved in music education, such as music teachers. Also, graphic design students and professors may use the information in this thesis to advance their understanding of visualizing complex information. The final application, the website, can be put into a CD-ROM and may be distributed as well.



Thesis Show Announcement

Panel 1


MFA Thesis Show
April 3, 2006 - April 19, 2006
Bevier Gallery
James Booth Building 7A
Graphic Design
Music Education for Children
Thesis Show for the Masters of Fine Arts Degree
Graduate Graphic Design
School of Design
College of Imaging Arts and Sciences
Rochester Institute of Technology
Sophia Choi
Candidate
Spring 2006

Panel 2

Thesis Definition

Children can gather and retain information quicker when it is visually displayed as opposed to just vocally stating the facts. Understanding and using both visual and vocal methods of teaching can drastically improve how children retain and understand musical components (major scale, melody, harmony). Therefore, it is important to visualize the musical components. The purpose of this thesis is to develop a visual system to explain complex and abstract concepts. The abstract ideas of major scale, melody and harmony are redefined through visual elements which will contribute to an improved musical instruction.

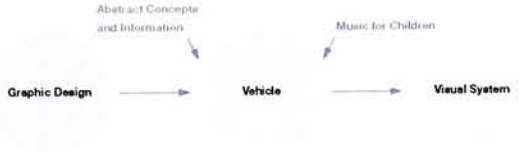
Content

Graphic Design Problem

Music is confirmed through various degrees of sounds. Therefore, it is difficult to understand music through just sounds. Music includes sounds, scale, melody, harmony, notes, as well as other components. These are abstract ideas that are difficult to visualize.
The focus of this thesis is to determine how graphic design decision-making can influence our understanding of these abstract ideas. This thesis will identify specific visual elements and show how the treatment of those elements can amplify or diffuse abstract ideas.

Application

This thesis focuses on translating the music components into visual elements effectively, which will enable children to understand the basic principles that lead to music appreciation. Moreover, this thesis benefits society because it develops a relationship between graphic design and music, and it establishes a new teaching method of music education for children.



Goals

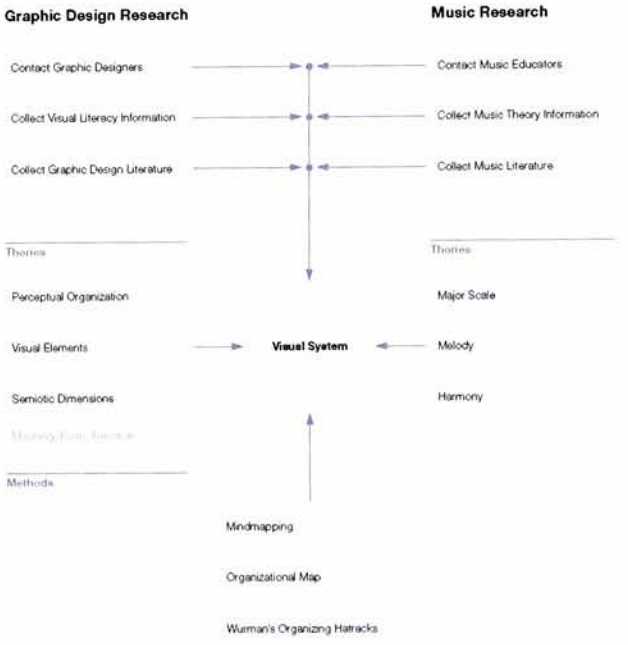
- To identify specific visual elements and show how the treatment of those elements can amplify or diffuse abstract and complex ideas.
- To provide an increased understanding of the major scale, melody, and harmony through a visual theory application.
- To present the possible use of graphic design as a teaching method in music education for children.

Thesis Research

This thesis research identifies various aspects of the number, position, direction, shape, color, texture, and surface-quality attributes in the visual field. It also considers the process of perception, which is the interpretative activity children use to ascribe meaning to these optical differences in the visual field. The music research for this thesis includes fundamental music theory and musical components. This research begins with the analytical understanding of the major scale, melody and harmony.

Research Process

The research process involves more than just gathering facts, it requires a planned process of organizing information from a range of different resources.

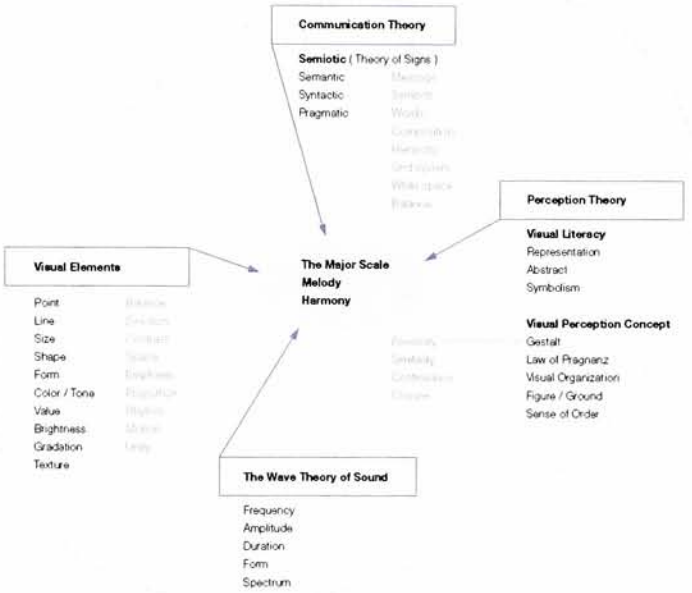


Panel 3

Thesis Synthesis

This thesis synthesis combines information, facts and materials into a unified problem statement to further guide research and investigation. This diagram was constructed to determine the most effective organizational structure for communicating the collected research.

Organizational Diagram

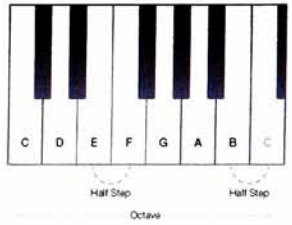


Thesis Ideation

The Major Scale

The major scale is defined as a specific pattern of small steps (half steps) and large steps (whole steps) encompassing an octave. A half step is the distance from a white key on the piano to the next white or black key. Using only the white keys on the piano, there are two half steps in each octave.

Concept sketches presented representing major scale were developed to use line weight and value to reinforce the relationship of intervals among pitches (highness or lowness of sound). This ideation shows foundations on which the major scale can be built according to its pitches.



Melody

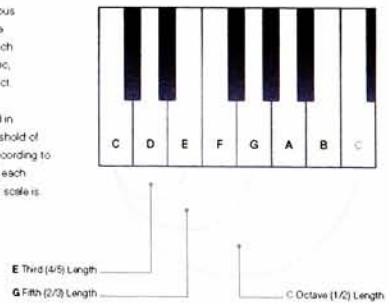
Melody is defined as a group of pitches played one after another which appear as a line of notes that move upward or downward depending on the kind of notes selected. As an entity, the repetition of pitch is an important factor in any melody. Melodies also have a sense of line in its presentation, meaning that melodic pitches rise and fall and are perceived as high and low. Following this, the grid system can be used to determine the sequence of melody.

- An interval is the measurement of the vertical (pitch) distance between two notes, as opposed to the horizontal (time) difference. A harmonic interval results if the notes are performed at the same time, while a melodic interval occurs when the notes are played successively.

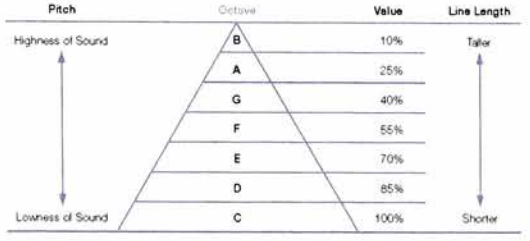
Harmony

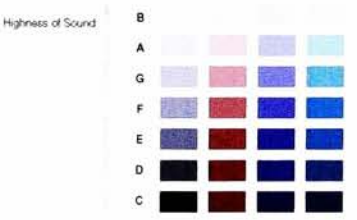
Harmony is defined as an aspect of music that pertains to simultaneous combinations of pitch. The combinations of different pitches enhance the quality of music. It is the sound that results when two or more pitch classes are performed simultaneously. It is the vertical aspect of music, produced by the combination of the components of the vertical aspect.

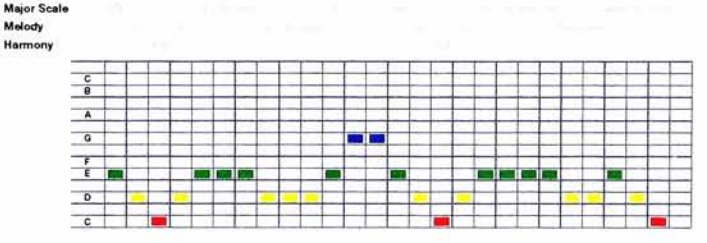
The wave theory of sound is consulted to understand physical sound in harmonics. The longest wave is 'C' in an octave and 'red' in the threshold of visibility. The concept sketches show the standard color schemes according to the specific ratio between harmonies. For example, the wave ratio of each C, E, G (1:4/5:2/3) which is the most important harmony in the major scale is equal to that of red, green, blue (1:4/5:2/3).



Panel 4

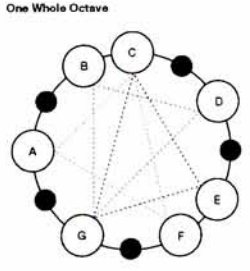


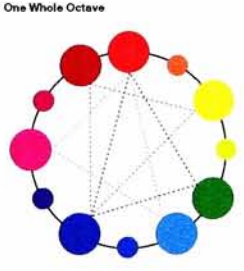


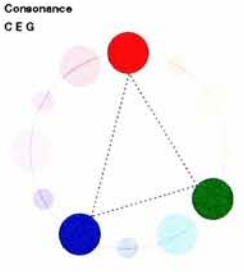


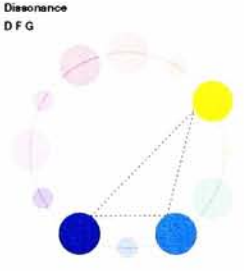
Application

From this ideation, different versions of this new visual system will be evaluated in a classroom by music educators. The most successful version will be implemented in an application for teaching the music components of major scale, melody, and harmony.









Retrospective Evaluation

This retrospective evaluation is a measurement of the Ideation and Implementation sections of this thesis. Identifying the weak and strong points of the project and understanding the problems will help determine how future versions of this project can be improved. This evaluation will also help establish goals for continued work on this project for the future.

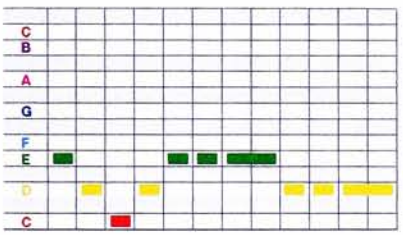
Professor Rachel Whitcomb
Assistant Professor, Music Education
rwhitco7@naz.edu

Dr. Mary Carlson, Assistant Professor/ Director of Music Education, Nazareth College introduced an elementary music specialist, Rachel Whitcomb, Assistant Professor, Music Education in Nazareth College to this thesis candidate.

To identify the weak and strong aspects of this project, these questions were asked:

Does this visual theory application provide an increased understanding of the major scale, melody, and harmony?

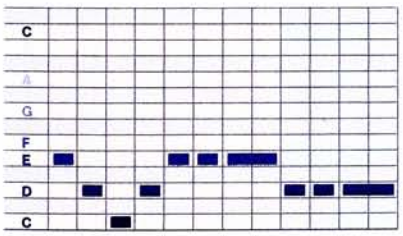
Combination 1



First, let me say that this is an interesting project and I am glad to help. I am always looking for ways to carefully and creatively connect music to other arts and disciplines outside of the arts, as the National Standards for Music Education state. Your project is certainly an impressive step in this process.

I think Combination 2 is more helpful than Combination 1 because visually it shows relationships between notes rather than different colors for each note. There is a visual system there that makes more musical sense, in my view. C is closer to D melodically, so it makes sense that the visual representation (color/shade) of C is closer to D. My suggestion here is to include the top scale tone (the high C), since students often do not hear the scale without the high tonal center.

Combination 2



I suppose Combination 1 could work if students were to memorize the colors that go along with the notes, but I don't know that this makes educational sense. It depends on the goals of the educator, but I don't think that different colors for different tones without some connection to their relationship musically are helpful.

Does this new visual system have potential to be an improvement over current methods of teaching the music fundamentals to children?

Absolutely. I think it allows children to see not only melodic relationships, but it has the potential to visually represent the timbre of particular instruments if you were to take it to that level (perhaps another thesis someday!). I also feel that there are learners who excel at artistic endeavors (or who are visual learners), and they will grab onto this method and understand it quickly. It is in many ways similar to the iconic representation that Jerome Bruner (and Bergethon, Boardman, and Montgomery) discusses.

Retrospective Evaluation

Can children retain and understand major scale, melody and harmony through this visual theory application?

I think the method in which it is used (the step by step procedures by the teacher) will either make or break it. It would be most effective if the children are exposed to this idea in early childhood and use it consistently throughout their musical study. I also feel that it should be used in combination with any visual/artistic instruction they are receiving.

Does this visual theory application present the possible use of graphic design as a teaching method in music education for children?

Yes, I think so, if done carefully and without losing the integrity of either discipline (music or graphic design). However, graphic design, or any other discipline, cannot take the place of music. Music is unique and like no other human experience. Children need opportunities to sing, play instruments, move, improvise, compose, listen, evaluate, and analyze music with others, in a live setting. I certainly feel that other arts and disciplines are naturally connected to music and have a place in the music classroom, as long as the music itself is not pushed to the side in any way.

Is the information in this visual theory application organized?

Yes, I could follow it easily.

Individual Evaluation

Individual evaluation is a process of critical thinking for developing a more effective visual system through professional feedback. The evaluation of Rachel Whitcomb shows that these visual examples (Combination 1 and 2) need to express the top scale tone (the high C). Therefore, the visualization of *Pop Goes the Weasel* was included to explain the high C. This is because *Pop Goes the Weasel* is a song with pitches above and below the tonic. In this thesis, the 2 notes (C note above and below tonic) are both the same color. For example, the color of the note in the low C is red and the color of the note in the high C is also red.

Additionally, Rachel Whitcomb expresses that the visual example using gradation of one color seems more effective than using the color-coding system because Combination 2 shows relationships between notes rather than different colors for each note. Therefore, the color gradation is shown in the final application so users of this website can use both versions.

Conclusion

The challenge of this thesis was to explore visual communication as a practical means to clarity and present information that is inherently abstract, complex and non-visual. From the many areas which can benefit from this kind of exploration, this thesis candidate chose music because there have not been many attempts to use visual elements even though they can be helpful in understanding musical elements. According to several scholars and educators, the effective visualization of music for children aged 6 to 10 is critical because they study the concepts of music for the first time at those ages. Therefore, this thesis candidate researched this area and developed a strategy to help make these music concepts clearer and more accessible for this age group.

The main goal of this thesis is to identify specific visual elements and show how the treatment of those elements can amplify and diffuse abstract and complex ideas. This thesis candidate researched communication theories, visual elements and perception theories in order to summarize and express these ideas. Also, several precedent attempts of visualization of music are researched and studied.

The secondary goal is to provide an increased understanding of the major scale, melody and harmony through the development of an effective, appropriate visual language and to present the possible use of graphic designs as an alternative teaching material in music education for children. To accomplish this goal, the precedent studies, music theory and the wave theory of sound are combined and developed through concept sketches.

Mission Statement Achieved

Based on feedback from design professors, music professors and the Retrospective Evaluation, this thesis candidate believes the goals of the mission were successfully reached. However, there were many difficulties encountered throughout this thesis. First, visualizing harmony was very challenging because harmony is an abstract idea which was hard to translate into a concrete visualization. Also, during the development of this project, this thesis candidate was inspired to explore rhythm which was not planned at the outset; therefore, analyzing rhythm was an additional challenge.

This thesis is applicable as a model for developing a systematic, analytical teaching/learning instrument for music education for children. It is expected that the process developed to amplify and diffuse abstract and complex ideas in this thesis will be helpful for the future analysis of information design. Information design refers to translating certain message into another easier, visual and verbal language.

Glossary of Terms

Design Terminology

Chroma	The purity of color or its freedom from white, black or gray. The intensity of a hue.
Design	Design is to create, fashion, execute, or construct according to a plan or structure, which considers functional and communicative objectives. Design is also concerned with the visual principles of formal goodness: shape, composition, value, color, etc.
Hue	This is the most characteristic dimension which identifies a color by name, i.e. red, green, blue, etc. Every color falls into a definite hue category when related to the spectrum rage of colors.
Ideation	The generation of conceptional solution and preparation of a range of preliminary design approaches.
Information Design	The defining, planning and shaping of the contents of a message and the environments in which it is presented, to achieve particular objectives in relation to the needs of the users.
Language	Language is an abstract system of word meanings and symbols for all aspects of culture. It also includes gestures and other nonverbal communication.
Mind Map	A written technique used to document stream of consciousness brainstorming using one subject as a springboard to another.
Pragmatic	The pragmatic refers to the relationship of a visual image to a user.

Glossary of Terms

Design Terminology

Semantics	This dimension of the semiotic model refers to the relationship of a visual image to meaning.
Semiotics	Semiotics is the analysis of the function of signs. The meaning or relationship of meanings of a sign or set of signs. A general philosophical theory of signs and symbols that deal with their function.
Sign	A mark having a conventional meaning and used in place of words or to represent an idea.
Syntactic	The syntactic dimension of the semiotic model refers to the relationship of one visual image to another.
Value	The characteristic of color determined by light or dark, or the quantity of light reflected by the color. The degree of lightness or darkness in a color.

Musical Terminology

Beat

A beat found within music is the regular recurring pattern which can be divided into equal units of time.

Consonance

Concordant or harmonious combination of pitches that provides a sense of relaxation and stability in music.

Chord

A combination of 3 or more pitches occuring simultaneously.

Frequency

The number of the vibrations per second; expressed in hertz (Hz).

Half Step

The closest pitch above or below any given pitch in Western music.

Harmony

Harmony is the sound that results when two or more pitch classes are sounded simultaneously. It is the vertical aspect of music, produced by the combination of the components of the horizontal aspect.

Interval

An interval is the relationship between two pitches, the lower and higher members of the interval, identified by number.

Note

A note is a symbol made up of a note head (in all cases), a stem (in some cases) and a flag or tail (in some cases). Notes bearing flags are grouped together using a beam.

Note Head

A note head is the empty or filled circle drawn on the staff used to indicate the pitch of a note.

Musical Terminology

Major Scale	The major scale is defined as a specific pattern of small steps (half steps) and large steps (whole steps) encompassing an octave. A half step is the distance from one key on the piano to the next immediate key. The structure of the major scale consists of 'whole step—whole step—half step—whole step—whole step—whole step—half step'.
Melody	Melody is defined as a group of pitches (highness or lowness of sound) played one after another which appear as a line of notes that move upward or downward depending on the kind of notes selected.
Octave	An octave is a series of eight pitches in a musical scale. It is also used to talk about the difference in pitch between the first and last pitches in a musical scale.
Pitch	Pitch is defined as highness or lowness of sound.
Rhythm	Rhythm is the movement of music in time; all things relating to temporal motion.
Staff	A musical staff represents the time line of musical sound events. It is generally made up of five lines and four spaces. Notes are placed on these lines and spaces to inform which pitch should sound, and the rhythmic value of that pitch.
Tone	A tone is a musical sound, one that can be heard as having a pitch.
Wavelength	The distance between nodes on two successive waves.

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Appendix A

Zoltán Kodàly

www.oake.org/php/aboutzotankodaly.php
March 2006

Zoltán Kodàly (1882-1967), prominent Hungarian composer and musician, directed a significant portion of his creative endeavors to the musical education of the Hungarian nation-an interest which developed over many years. Such efforts were initiated with the folk song collection beginning in 1905. As he became aware of the great need to improve the quality of singing and music training of teachers and children alike, he began composing for children's choruses in the 1920's and required his composition students to do the same. Folk music provided inspiration, as well as the musical basis, for many of the compositions. By 1929 he was determined to reform the teaching of music and to make it an integral part of the education of every child.

Kodaly Method

The Kodaly Method was developed in Hungary in the 1940s and 1950s. Zoltán Kodàly developed this teaching method in collaboration with his colleagues and his students. The primary goal of the Kodàly Method is to produce musical literacy by following four main objectives. These objectives are to develop to the fullest extent possible the innate musicality present in all children, to make the language of music known to children (to help them become musically literate in the fullest sense of the word – able to read, write, and create with the vocabulary of music), to make the children's musical heritage (the folk songs of their own language and culture) known to them, and to make available to children the great art music of the world, so that through performing, listening, studying, and analyzing the masterworks they will come to love an appreciation of music based on knowledge of music (Choksy & Abramson, 1986. p. 72). Americanstyle Kodàly "retains the use of pentatonic folk songs, the Tonic Sol-fa approach to sight reading with its hand signs, a rhythmic system of mnemonic syllables, and an emphasis on unaccompanied song" (Campbell & Scott-Kassner, 1995. p. 52). Some of the basic philosophies underlying the Kodàly approach are (1) all people capable of lingual literacy are also capable of musical literacy, (2) singing is the best foundation for musicianship, (3) music education, to be most effective, must begin with the very young child, and (4) only music of the highest artistic value, both folk and composed, should be used in teaching (Choksy & Abramson, 1986. p. 71).

Piaget's Theory of Cognitive Development

http://chiron.valdosta.edu/whuitt/col/cogsys/piaget.html

November 2005

Jean Piaget (1896-1980) was one of the most influential researchers in the area of developmental psychology during the 20th century. Piaget originally trained in the areas of biology and philosophy and considered himself a "genetic epistemologist." He was mainly interested in the biological influences on "how we come to know." He believed that what distinguishes human beings from other animals is our ability to do "abstract symbolic reasoning." Piaget's views are often compared with those of Lev Vygotsky (1896-1934), who looked more to social interaction as the primary source of cognition and behavior. This is somewhat similar to the distinctions made between Freud and Erikson in terms of the development of personality. The writings of Piaget (e.g., 1972, 1990; see Piaget, Gruber, & Voneche) and Vygotsky (e.g. Vygotsky, 1986; Vygotsky & Vygotsky, 1980), along with the work of John Dewey (e.g., Dewey, 1997a, 1997b), Jerome Bruner (e.g., 1966, 1974) and Ulrick Neisser (1967) form the basis of the constructivist theory of learning and instruction.

While working in Binet's IQ test lab in Paris, Piaget became interested in how children think. He noticed that young children's answers were qualitatively different than older children which suggested to him that the younger ones were not dumber (a quantitative position since as they got older and had more experiences they would get smarter) but, instead, answered the questions differently than their older peers because they thought differently.

There are two major aspects to his theory: the process of coming to know and the stages we move through as we gradually acquire this ability.

Process of Cognitive Development

As a biologist, Piaget was interested in how an organism adapts to its environment (Piaget described as intelligence.) Behavior (adaptation to the environment) is controlled through mental organizations called schemes that the individual uses to represent the world and designate action. This adaptation is driven by a biological drive to obtain balance between schemes and the environment (equilibration).

Piaget hypothesized that infants are born with schemes operating at birth that he called "reflexes." In other animals, these reflexes control behavior throughout life. However, in human beings as the infant uses these reflexes to adapt to the environment, these reflexes are quickly replaced with constructed schemes.

Piaget described two processes used by the individual in its attempt to adapt: assimilation and accomodation. Both of these processes are used thoughout life as the person increasingly adapts to the environment in a more complex manner.

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Assimilation is the process of using or transforming the environment so that it can be placed in preexisting cognitive structures. Accomodation is the process of changing cognitive structures in order to accept something from the environment. Both processes are used simultaneously and alternately throughout life.
An example of assimilation would be when an infant uses a sucking schema that was developed by sucking on a small bottle when attempting to suck on a larger bottle. An example of accomodation would be when the child needs to modify a sucking schema developed by sucking on a pacifier to one that would be successful for sucking on a bottle.

As schemes become increasingly more complex (i.e., responsible for more complex behaviors) they are termed structures. As one's structures become more complex, they are organized in a hierarchical manner (i.e., from general to specific).

Stages of Cognitive Development
Piaget identified four stages in cognitive development:

1 **Sensorimotor stage** (Infancy). In this period (which has 6 stages), intelligence is demonstrated through motor activity without the use of symbols. Knowledge of the world is limited (but developing) because its based on physical interactions/ experiences. Children acquire object permanence at about 7 months of age (memory). Physical development (mobility) allows the child to begin developing new intellectual abilities. Some symbollic (language) abilities are developed at the end of this stage.

2 **Pre-operational stage** (Toddler and Early Childhood). In this period (which has two substages), intelligence is demonstrated through the use of symbols, language use matures, and memory and imagination are developed, but thinking is done in a nonlogical, nonreversable manner. Egocentric thinking predominates

3 **Concrete operational stage** (Elementary and early adolescence). In this stage (characterized by 7 types of conservation: number, length, liquid, mass, weight, area, volume), intelligence is demonstarted through logical and systematic manipulation of symbols related to concrete objects. Operational thinking develops (mental actions that are reversible). Egocentric thought diminishes.

4 **Formal operational stage** (Adolescence and adulthood). In this stage, intelligence is demonstrated through the logical use of symbols related to abstract concepts. Early in the period there is a return to egocentric thought. Only 35% of high school graduates in industrialized countries obtain formal operations; many people do not think formally during adulthood.

Wavelength

http://eosweb.larc.nasa.gov/EDDOCS/Wavelengths_for_Colors.html

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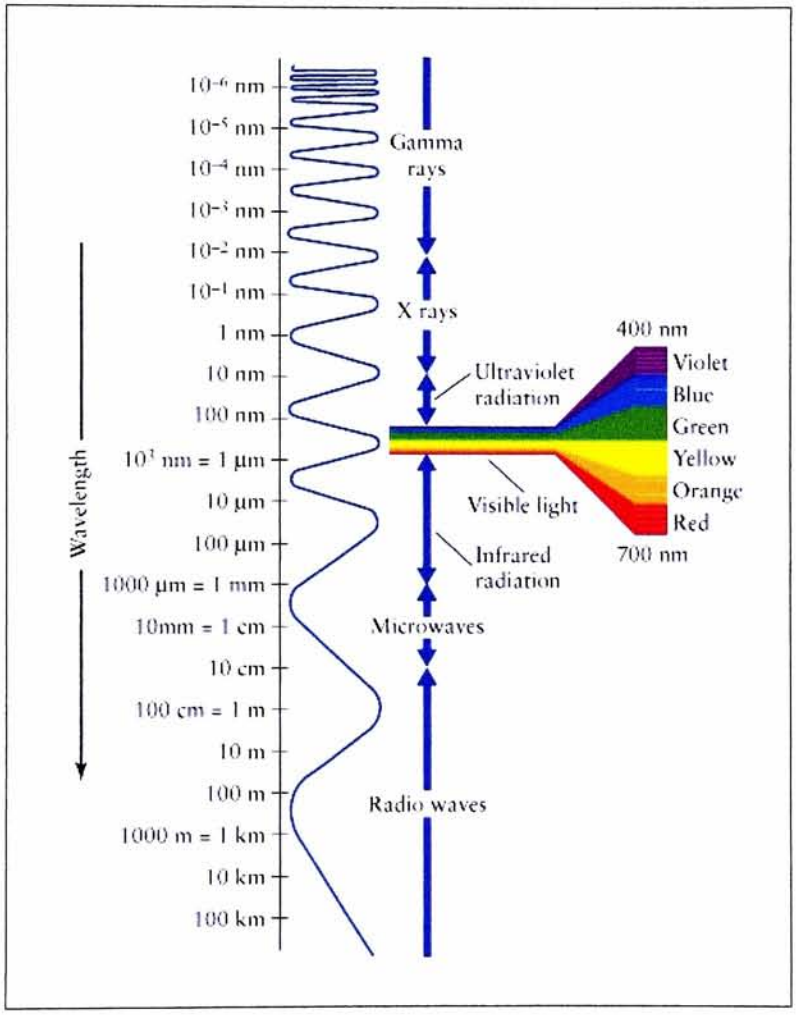
Our eyes are sensitive to light which lies in a very small region of the electromagnetic spectrum labeled "visible light". This "visible light" corresponds to a wavelength range of 400–700 nanometers (nm) and a color range of violet through red. The human eye is not capable of "seeing" radiation with wavelengths outside the visible spectrum. The visible colors from shortest to longest wavelength are: violet, blue, green, yellow, orange, and red. Ultraviolet radiation has a shorter wavelength than the visible violet light. Infrared radiation has a longer wavelength than visible red light. The white light is a mixture of the colors of the visible spectrum. Black is a total absence of light.

Wavelength image from *Universe* by Freedman and Kaufmann



Ideation Sketches for Thesis Show panels