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공학석사학위논문

**Architectural Expressions of Music:  
Perceptions of Musically Inspired Architecture**

음악의 건축적 표현: 음악적 요소를 반영한 건축에 대한 인식

2016년 8월

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지도교수 최 재 필

이 논문을 공학석사 학위논문으로 제출함

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유 세 원

유세원의 공학석사 학위논문을 인준함

2016년 8월

위 원 장 \_\_\_\_\_

부위원장 \_\_\_\_\_

위 원 \_\_\_\_\_

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**Abstract**

## **Architectural Expressions of Music: Perceptions of Musically Inspired Architecture**

Yoo, Saewon  
Department of Architecture  
Master Course in Graduate School  
Seoul National University  
Advised by Professor Choi, Jaepil

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We live in a culture that easily privileges the stimulation of the eye more than the ear. When perceiving a matter, it is common to immediately absorb the visual information. However, if the information of the subject approaches with the sense of hearing, the method of how to directly visualize the matter must be examined as much as the sense of sight. Just as many thinkers and architects have noted the relationship between the senses of sight and hearing, music and architecture have an intimate relationship in the same context.

Since music relies on sense of hearing and architecture relies on sense of sight, architecture has the advantage of visualizing music. By applying musical characteristics in architecture, it can produce creative and scientific design method, provide the enjoyable attraction for visitors, and reflect the social and cultural properties of the particular period. The purpose of this research is to examine the experience of musically inspired architecture, and to analyze the correlations between music and architecture with what architectural and musical

factors form such experience. In order to achieve this goal, the history and relationship between music and architecture are examined. Then the case studies of musically inspired architecture are analyzed by the use of musical elements. Through the survey questionnaires to the architecture, music, and other majors on experience of music and architectural façades, the keywords on how people perceive music from architecture are extracted and analyzed.

This research will determine the possibility of applying musical properties to architecture and what musical and architectural elements correlate to each other. The results of this study will help providing the ideas of creative design effectively for architects who desire to express the musical qualities through architecture.

**Keywords : Music and Architecture, Perception, Architectural Expression**

**Student Number : 2014-22630**

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# **Chapter 1 Introduction**

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**1.1 Background and Purpose**

**1.2 Organization of Research**

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## 1.1. Background and Purpose

At least from 6th century B.C., it was claimed that music and architecture were connected with the universe. This was understood by mathematics and geometry, and many Greek temples were designed with the principles of proportions. The Greek thinkers attempted to find the order of law from the human body proportion and musical scale proportion.<sup>1)</sup>

There is a famous statement by Johann Wolfgang von Goethe, a German writer and a politician, who stated, “Music is liquid architecture; architecture is frozen music.” The Greeks, who just started to understand the proportional system in architecture with the music background, thought that the perfect proportional started from the harmony of music, so they have compared architecture to frozen music as well. Through the numerical values and proportional system, the structural relationship of music can be substituted as a visual understanding of architecture. Even after the Greeks’ explorations of music and architecture, the architects who were interested in this method continued to use this approach by applying to the new schemes.

According to the *Concise Oxford Dictionary*<sup>2)</sup>, music is defined the art of combining sounds and silences by time, in a way that creates harmony and usually transmits an emotion. Architecture is the art of designing through space, and complex organization and coordination of heterogeneous composite. Although music relies on sense of hearing and architecture relies on sense of sight, these two types of art share many correlations as it will be explained in the following chapter. Therefore, there is an advantage of using the architecture that is able to be seen to visualize the music that cannot be seen. According to the preceding studies (Table 1), the application of musical characteristics in

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1) Yoon, Hee-Cheol, *Dialogues between Contemporary Architecture and Music*. Spacetime: Shigongmunhwasa, 2005.

2) *The Concise Oxford Dictionary*. Allen, R.E., ed. 1992. Clarendon Press. Oxford: 781

architecture can produce creative and scientific method, provide the enjoyable attraction for visitors, and reflect the social and cultural properties of the particular period.

[Table 1-1] Preceding Studies of Music and Architecture

No.	Title	Author	Year	Keywords	Purpose	Conclusion	Research Method	
							Literature Review	Case Studies
1	Musical Analogy in Gothic and Renaissance Architecture - A Study of Rational Proportion in Architecture	Dae-Am Yi, University of Sydney Ph.D Dissertation	1991	Gothic architecture, Renaissance architecture, Proportion	To demonstrate that architectural proportion was derived from systems of knowledge prevalent in the Medieval and Renaissance eras, not by the architect's own judgements	The use of musical proportion in Gothic and Renaissance architecture was not accidental, but intentional.	O	O
2	Architecture as a Translation of Music	Elizabeth Martin	1994	Architecture and music	To give another sense to the numerous ways music and architecture have mutated and cross-fertilized on another	Music has not yet freed itself from the straight and narrow of time, and architecture may have broken the box, but it has yet to break out of its cage.	O	O
3	A Study on the Relationship of Architecture and Music - Focused on Otto Wagner and Gustav Mahler	Hong-Kyu Lee, Jung-Kue n Dong, Journal of Architectural Institute of Korea	1996	Architecture and Music	To study the correlation between music and design, and to show the possibility to make architecture through works of Otto Wagner and Gustav Mahler	Incorporating music into architecture produces a creative designs, and it reflects the spirit of the period.	O	O
4	A Study on the Relationships between Renaissance Architecture & Renaissance Music	Hee-Cheol Yoon, Journal of Daejin University	1996	Renaissance architecture, Architecture and music	To see how Renaissance architecture started to apply music into architecture	Music and architecture had a deep relationship on the theory of proportion since the proportion of cosmic harmony, so applying music into architecture is a scientific way of designing in architecture.	O	O

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5	A Study on the Expression Method for Environmental Design through Relative Investigation between Music and Architecture	Hee-Jung Kim, Ewha Womans University Interior Design Masters Dissertation	1997	Music and architecture, Environmental design	To see the relationship between music and architecture as the access towards creativity, and enhance the environment around people by applying musical system.	Applying musical system makes the design to be more creative and supplements problems, the law of architectural form and the standard of music can be shared according to their similarities, rhythms can create a variety of forms, and there can be a method of design where both time and space exists at the same time.	O	
6	A Study on the Relationship of Architecture and Music by Aesthetical Constituent Factor - Focused on the Recent and the Present Age	Suk-Han Jung, Ho-Chin Lee, Journal of Architectural Institute of Korea	1998	Architecture and music. Aesthetical constituent form	To suggest a new direction of architectural designs through the comparison of aesthetical constituent factor of music and architecture	Music and architecture have 90% similarities in terms of aesthetical constituent forms, which means that there needs to be interchanges between music and architecture.	O	O
7	A Study on the Relationship between John Cage's 'Music of Change' and Bernard Tschumi's 'New National Theater' - Focus on the Theory of Composition	Tae-Jun Youn, Young-Min Koo, Journal of Architectural Institute of Korea	1998	Indeterminate theory. Coding device. Programmatic notation	To analyze the way how the musical codes are transformed to a design device for programmatic notation, and to define a new theoretical interrelationship between music and architecture in contemporary age filled with indeterminacy	The musical interpretation in architecture now suggests the new possibilities of not just the basic principles of composition, but also the changes in the whole design concept.	O	O
8	A Study on the Analogy between Architecture and Music in the Theory of Musical Form	Sung-Hoon Moon, Seung-Je Kim, Journal of Architectural Institute of Korea	1999	Architecture and music. The theory of musical form. Modeling	The elements and principles of compositions from music and architecture are analyzed to see what intentions and properties music has in architecture.	In design, the application of musical system makes suitable combination, and through the study of similarities between music and architecture, it will be the instrument that supplements the problems of expressing in design and produce creative designs.	O	

9	A Study on the Relationship between Music and Architecture in the 20th Century - With Reference to Time and Space	Young-Hee Kim, Journal of Korean Institute of Interior Design	2000	Time and space. Music and architecture	By identifying the 20 <sup>th</sup> century music and architecture with the reference to time and space, this study offers the possibility of the integration, and promotes a new nature of science, music and architecture.	The suggestion of possibility of integrating music and architecture in time and space, which will help us understand the reality of art.	O	O
10	A Study on Relationship between Architecture and Music I	Mi-Ran Lee, Korea Institute of Illustration Art	2002	Music and architecture	To see the relationship between music and architecture as the access towards creativity, and specify the relationship by looking at case studies	The relationship between music and architecture already existed in the past, and this will be the new methodology that will trigger creativity.	O	O
11	Hybrid Different Media: Music and Architecture	Kiho Choi, Syracuse University B. ARCH	2003	Hybrid. Music and architecture. Bartok. Music theory	To see the hybridity of music and architecture by poetically analyzing musical instruments	According to Bela Bartok's musical theory, the axis system has hierarchy among the harmony of music, which represents how to compose and group the music pattern.	O	
12	A Design Tool for Practical Application of Musical Proportions in Architecture	Seung-Yeon Choo, Journal of Architectural Institute of Korea	2004	Architectural Theory. Musical Proportion. Facade. CAAD, Museum der Moderne in Salzburg	To propose a solution of architectural practice as a design assistant with an application method of musical proportion theory, and on how this theory translates into computer language and apply to the system of CAAD(Computer-Aided Architectural Design)	It is not the best method to apply musical proportion theory in the level of where the specification of the field of music was not established in architecture. However, this research proposes the possibility of using the reinterpretation of musical proportion theory and the computer as the design assistant.	O	O
13	Dialogues between Contemporary Architecture and Music	Hee-Cheol Yoon	2005	Music and architecture	To see the artistic side of music and architecture's relationship, and to look at the relationship between the graphic arts and music by looking at case studies as a method of design.	It is necessary for graphic designers and musicians to study in depth about the different genres of art to their field for the production of creative and differentiated works.	O	O

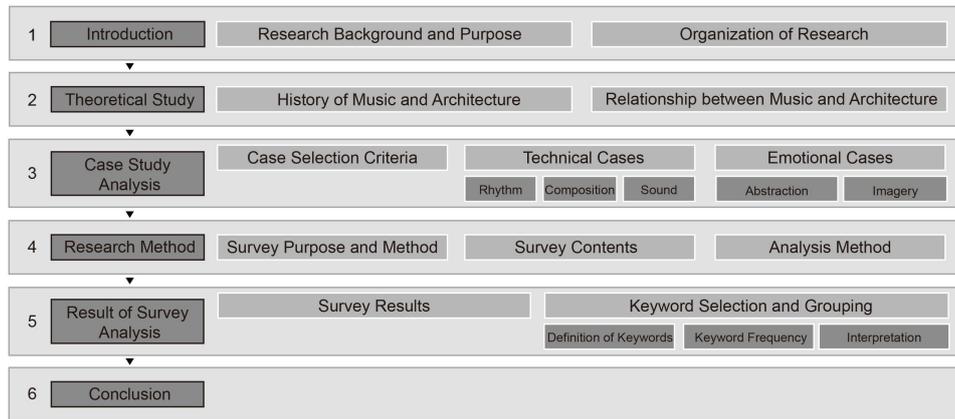
14	Architecture & Music	Sung Hoon Moon, Journal of Architectural Institute of Korea	2010	Music and architecture	To see the similarities between music and architecture, and how music influences architecture	In design, the application of musical system makes suitable combination, and the common principles of the composition are able to be visualized, which makes the design to be more creative and supplements problems.	O	O
15	A Study on the Integrated Teaching Method of Minimal Architecture and Minimal Music	Seon-Mi Ma, Chung Nam University Music Education Masters Dissertation	2012	Minimal music. Minimal architecture. Minimalism. Music and architecture. Music education	To improve students' thinking skills and creativity	Since music is important product that reflects social and cultural properties of the current period, it will be helpful for the students to learn music.	O	O
16	Architecture becomes Music	Charles Jencks	2013	Music and Architecture	To see the architecture that becomes music	Architecture and music are not only supremely emotional, but semantic and meaningful.	O	O
17	A Study on the Algorithm-Based Free Form Generation for the Application of Music to Digital Architectural Design	Seung-Hak Woo, Seung-Yeon Choo, Journal of Architectural Institute of Korea	2014	Music Theory, Form Generation, CAAD, BIM, Algorithm, Visual Programming Language	To suggest an architectural methodology to materialize auditory impression of music as spatial impression in architecture.	Digital architectural design from music and BIM application methodology may be used in the beginning level of architectural design in order to create a variety of designs.		O

The purpose of this research is to examine the experience of musically inspired architecture, and to analyze the correlations between music and architecture with what architectural and musical factors form such experience. In another words, this research focuses on what people perceive from music and architecture, and how to apply musical features in architecture more effectively.

## 1.2. Organization of Research

Figure 1-1 demonstrates the flow of the research. In chapter 2, the history and relationship between music and architecture are examined as the theoretical study. Then in chapter 3, the case studies of musically inspired architecture are

analyzed by dividing the cases with technical and emotional cases. Chapter 4 describes the research method with the survey purpose and method, survey contents, and method of the analysis. In chapter 5, the results of the survey and the keywords on how people perceive music from architecture are extracted and analyzed. This research will determine the possibility of applying musical properties to architecture and what musical and architectural elements correlate to each other.



[Figure 1-1] Research Flow Chart



## **Chapter 2 Theoretical Study**

---

### **2.1 History of Music and Architecture**

2.1.1 Pythagoras' Discovery

2.1.2 Harmony of Universe

2.1.3 Greek and Renaissance

### **2.2 Relationship between Music and Architecture**

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## 2.1. History of Music and Architecture

The Medieval and Renaissance architects shared the world view that was derived from the Greeks. They have considered that the universe and the proportion of musical scale are able to control the harmony of universe and the movements of planets.<sup>3)</sup> The Roman architect, Marcus Vitruvius Pollio(80 BC~70 BC) asserted that just as music is the proportion of science, architecture is also science that relies on order and proportion, which therefore, makes the statement that architects are to understand music through the principles of proportion.<sup>4)</sup>

In *The Ten Books on Architecture*, in the section of Education of the Architect, Vitruvius also has stated that “Music, also the architect ought to understand so that he may have knowledge of the canonical and mathematical theory...” (8).<sup>5)</sup> Based on this writing, Leon Battista Alberti (1404~1472) commented that beauty exists when the harmony is inherent in the building, and can be detected by rational means. Its chief characteristic is the classical idea of maintaining a uniform system of proportion throughout all parts of a building.<sup>6)</sup> Thus, the merging of music and architecture has been established with the long history beyond what the public is aware of.

### 2.1.1. Pythagoras’ Discovery

This all started from the Ionian Greek philosopher and mathematician, Pythagoras (570 BC~495 BC). He has greatly influenced in the Western civilization, and his philosophy makes the divergence of diverse fields elaborated

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3) Yi, Dae-Am, Musical Analogy in Gothic and Renaissance Architecture - A Study of Rational Proportion in Architecture, Doctoral Degree thesis, University of Sydney.

4) Moon, Sung-Hoon. Architecture and Music. Journal of Architectural Institute of Korea, 54(8), 2010.

5) Pollio, Vitruvius, M. H. Morgan, Herbert Langford Warren, and Nelson Robinson. Vitruvius: Ten Books on Architecture. Charleston, SC: BiblioBazaar, 2008. Print.

6) Wittkower, Rudolf. *Alberti’s Approach to Antiquity in Architecture*. London: The Warburg Institute, 1940.

rather than just considering them as self-contained fields. He works on a basis of number. He derives the lawful numerical ratios 1:2:3:4 from the principle of concords, which links to the fields of philosophy, arithmetic, geometry, art and music. He has also influenced heavily on Greek art. The Greek architects and sculptors tried to find the mathematical relation that would direct to the perfection of aesthetics.<sup>7)</sup>



[Figure 2-1] Pythagoras' Discovery of Scale Ratio

Source:

<http://arthistoryresources.net/renaissance-art-theory-2014/pythagoras-music-proportion.html>

Pythagoras has focused on the fact that musical intervals could be expressed as numerical ratios and that the more constant intervals had ratio with very small numbers, like 1:2. He has discovered this by accident when he happened

<sup>7)</sup> Christensen, Thomas, ed. *The Cambridge History of Music Theory*. Cambridge: Cambridge University Press, 2002.

to hear the sound of hammering by a blacksmith and wondered about why the sound was so rich and sonorous. (Figure 2-1)<sup>8)</sup> In order to find out the details of the hammering sound, Pythagoras has weighted all the hammers, and tried numerous experiments. Eventually, he has found out that their weights were in a ratio of 16, 12, 9, 8, 6 and 4, which was able to actualize the intervals he had heard the hammering sound of the blacksmith. Pythagoras has discovered the correlation between weight ratio and interval, and found out the vibrational frequency of a stretched string is inversely proportional to its length. This led Pythagoras to refer the relationship between music and architecture as not only musically and mathematically, but also philosophically. What he did was to create what he termed *harmonia* (unity, “fitting together”) within the scale. He stated that the understanding of *harmonia* would teach humankind immutable laws and appeal to the higher, rational intellect; it balanced the limitless and the limited, heaven and earth.<sup>9)</sup>

### 2.1.2. Harmony of Universe

From the discovery of musical laws, and the theory of order in musical sounds, Pythagoras and his followers have connected to the thought that the same order and relationship is found in nature and the universe. He believed that the universe is like a giant musical instrument, where each planet develops the system of sound like the strings making the harmony of the inherent sounds that was formed by the system of sounds. Pythagoras also thought that the secret of the harmony of universe was proportion, and that proportion was created with numbers. His idea was called ‘music of the sphere’ or ‘cosmic music,’ which influenced the eras of Roman, Medieval and Renaissance.<sup>10)</sup>

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8) Gaffurio, Franchino. *The Theory of Music*. Music Theory Translation Series. New Haven: Yale University Press, 1993.

9) Huffman, Carl. *Philolaus of Croton*. Cambridge: Cambridge University Press, 1993.

10) Yi, Dae-Am. *Essays on Time, Space, and Music in Architecture*. Seoul: Daewoo Publishing, 2001.

Plato (429 BC~ 347 BC), a philosopher in Classical Greece thought that the world is the living organism with a soul as well as body, since man is a copy of the universe. In his perception, “anything that has come to be must be corporeal, visible and tangible”<sup>11)</sup> and it has been created by the Demiurge, the Creator of the world, so that the body of the world was described to be formed from fire and earth. The fire was significant to make it visible and the earth was essential to make it to be able to be touched. It was necessary to have this bond in order to combine them together. The bond between fire and earth is proportionally formed. The Artificer inserted ‘air’ and ‘water’ as the means between the two extremes of fire and earth, and made them proportional to each other. (Figure 2-2)<sup>12)</sup>

Plato believed that the harmony of universe consists of numbers as well. This harmony started from one unity and it was expressed as the concept of two dimensional square and three dimensional cube. This can be discussed by dividing into two kinds of geometric progress, the concept of square is 1,2,4,8 and the concept of cube is 1,3,9,27. Plato represented the harmony of world as the form of the Greek letter, *lambda*( $\lambda$ ), (Figure 2-3)<sup>13)</sup> and expressed the secret in macro cosmo and micro cosmo, the harmonic constitution of the World-Soul, in a simple whole number such as 1,2,3,4,8,9,27 and in musical scale. The proportion in the numbers includes not only the consonance from all music, but also includes the composition of music and human soul.<sup>14)</sup>

11) Lippmann, Edward. *Musical Thought in Ancient Greece*. New York: Columbia University Press, 1964.

12) Pollio, Vitruvius, M. H. Morgan, Herbert Langford Warren, and Nelson Robinson. *Vitruvius: Ten Books on Architecture*. Charleston, SC: BiblioBazaar, 2008. Print.

13) Macrobius, Ambrosius Aurelius Theodosius. *Commentary on the Dream of Scipio*. Translated by Stahl, William Harris. New York: Columbia University Press, 1990.

14) Wittkower, Rudolf. *Architectural Principles in the Age of Humanism*. W.W. Norton & Company, 1971.



All of this philosophy led to many Greek temples to be designed on proportional principles revealing not only supreme beauty but as well as ‘the music of the heavenly spheres.’ Moreover, Alberti has asserted that the harmony of sound that gives delight to the ears is similar to giving delight to the eyes and heart. Therefore, architects needs to borrow the ideas from the musicians who are knowledgeable of the harmonic relationship.<sup>15)</sup> After Alberti’s remark, it has intrigued the architects to apply musical theory to architecture, and the philosophers, music theorists and scientists to put forward to various musical analogies in accordance with different musical scales and cosmologies.

## **2.2. Relationship between Music and Architecture**

Music and architecture are arts that express emotions, and at the same time show the logical and systematic form of law. Music can be defined as an art of time and architecture as an art of space, which cause to feel the aesthetic emotions from the composition. This also leads to the point that music can change the meaning of space depending on what kind of music is playing in the space. The components of music, rhythm, melody, harmony, timbre, and tone color can be defined in the components of architecture, point, line, surface, material, and color. (Table 2-1)<sup>16)</sup> Moreover, in music and architecture, proportion exists. In music, the harmony is created through the speed of rhythm or chords of notes. In architecture, it usually presents the beauty of architecture by using sizes as proportion.

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15) Alberti, Leon B. *On the Art of Building in Ten Books*. Translated by Rykwert, Joseph, Leach, Neil, and Tavernor, Robert.. Cambridge: The MIT Press, 1988.

16) Jung, Suk-Han, Lee, Ho-Chin. A Study on the Relationship of Architecture and Music by Aesthetical Constituent Factor. *Journal of Architectural Institute of Korea*, 18(1), 1998.

[Table 2-1] Similarities between Music and Architecture

Music	Architecture
Rhythm	Point
Melody	Line
Harmony	Surface
Timbre	Material
Tone Color	Color

Music and architecture have been compared in aesthetic terms according to their “mood” or “texture.” Goethe also have described the architecture musically as “music grown silent.”<sup>17)</sup> Furthermore, music and architecture have been compared in terms of the structural similarities in the elements of rhythm, interval and repetition. This can be done by comparing the composition of the music and the interior of the architecture.

Mi-Ran Lee also states that there are three ways of describing the relationship.<sup>18)</sup> First, the relationship is expressed in the aspect of form. Since music is systematically composed in the flow of time, it is an art based on time that gives the aesthetical emotion from the sound in the composition. Music is composed by in the background of rhythm, melody, and harmony using the tone of music, dynamics, speed and changes of the notes. On the other hand, architecture is a spatial art that expresses the form by the proportion, balance, contrast, repetition and unity using point, line, form, material and color. The primary similarity between music and architecture is that they both do not bring the form from the existing thing, but they both establish the art mentally. Second, the relationship can be explained in the aspect of creative expression. Different from natural science where it seeks for objective accuracy, art

17) Eucken, Rudolf C. *Main Currents of Modern Thought*. Vol.30-31. Richmond: Center for Integrated Education, 1973.

18) Lee, Mi-Ran. *A Study on Relationship between Architecture and Music I*. Korea Institute of Illustration Art, 2002.

emphasizes to give the freedom of human thought and emotion. The emotion of human combines a variety into one in the perception, and condenses the various symbols into one. This leads to the fact that the beauty of art starts from emotion. The emotion is part of the ability to perceiving art just like human's rationality and discernment. When thinking about what music and architecture contain, it deals with the inner world of human, in another word, emotion. Lastly, the relationship can be seen in the aspect of method of transmitting the concept. In order to convey the completed music and architecture, there needs to be some kind of symbol. The process of conveyance is similar in music and architecture in the semiotic perspective.

Thus, it can be said that architecture creates the space by physical material, and music creates space by sounds. Even though music and architecture are arts that have different ways of expressions, generating the art that provides the sense of sight and hearing at the same time by using the similarities of both arts will offer new and innovative experiences to the visitors.



# Chapter 3 Case Study Analysis

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## 3.1. Case Selection Criteria

## 3.2. Technical Cases

3.2.1. Rhythm

3.2.2. Composition

3.2.3. Sound

## 3.3. Emotional Cases

3.3.1. Abstraction

3.3.2. Imagery

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### 3.1. Case Selection Criteria

The total of 45 cases on musically inspired buildings is studied. The cases are divided into technical and emotional cases. The technical cases include buildings that were inspired by the musical elements that are utilized professionally in music such as rhythm, composition and sound of music. The rhythm consists of beats, proportion, and frequency of the music and sound, the composition consists of sequence and structure of the music, and the sound consists of chords, glissando, volume and echo. On the other hand, the emotional cases include buildings that were inspired by abstraction and imagery of music. The abstraction cases are buildings that express the emotions by the overall feelings that do not have specific forms, while the imagery cases express the emotions by imagining the actual matter. There were buildings that were applied with a specific piece of musical score, and buildings that applied the general musical properties. Moreover, in most of the cases, the architects designed the buildings according to the music, but some buildings were designed first and then the music was composed inspired by the building.

### 3.2. Technical Cases

#### 3.2.1. Rhythm

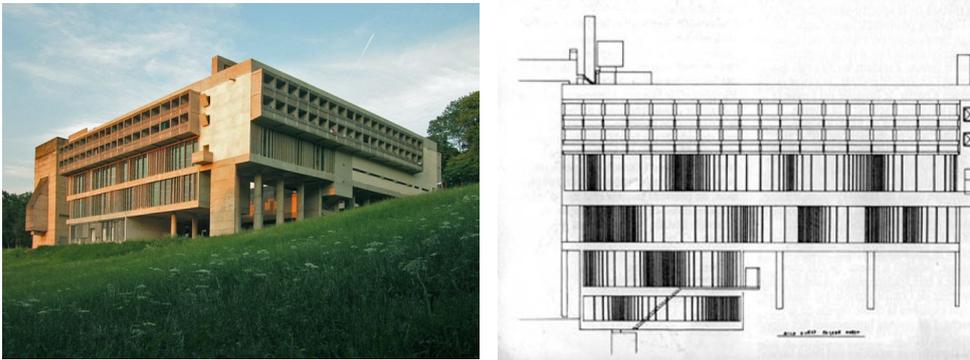
[Table 3-1] Technical Cases - Rhythm

No.	Name	Architect	Year	Location	Architectural Element	Musical Element
1	San Miniato al Monte	Bishop Alibrando	1018	Florence, Italy	Plan	Rhythm
2	St. Michael's Church	-	1022	Hildesheim, Germany	Plan	Rhythm
3	Basilica of Sant'Ambrogio	-	1099	Milan, Italy	Plan	Rhythm

4	Santa Maria in Cosmedin	Pope Hadrian I	1124	Rome, Italy	Plan	Rhythm
5	Santa Maria del Fiore	Fillippo Brunelleschi	1436	Florence, Italy	Plan, Section	Proportions
6	Villa Barbaro	Andrea Palladio	1560	Veneto, Italy	Plans	Proportions
7	Villa La Rotonda	Andrea Palladio	1570	Vicenza, Italy	Façade, Plan	Proportions
8	Monastery of La Tourette	Iannis Xenakis	1957	Lyon, France	West façade window	Proportions, Sound(glissando)
9	Philips Pavilion	Iannis Xenakis	1958	Brussel, Belgium	Façade	Rhythm, Sound
10	Disney Concert Hall	Frank Gehry	2003	Los Angeles, USA	Façade	Rhythm
11	Museum der Moderne in Salzburg	Friedrich Hoff Zwink Architekten	2003	Bonn, Germany	Façade	Proportion
12	Hotel Fouquet	Edouard Françoise	2006	Paris, France	Façade	Rhythm
13	CaixaForum	Herzog & de Meuron	2008	Madrid, Spain	Façade	Rhythm
14	Brandhorst Museum	Saverbruch Hutton	2011	Munich, Germany	Façade	Rhythm
15	Heydar Aliyev Center	Zaha Hadid Architects	2012	Baku, Azerbaijan	Composition, Façade	Rhythm, Fluidity
16	Chameleonic Academy	Carlos Arroyo	2012	Dilbeek, Belgium	Façade	Rhythm
17	Pavilion 21 MINI Opera Space	Coop Himmelbl(u)au (Wolf Prix)	2013	Munich, Germany	Façade	Frequencies of the sound file
18	Music Conservatory in Paris' 17th Arrondissement	Basalt Architects	2013	Paris, France	Volume of music rooms	Beat of melody
19	Busan Opera House	Orproject	2014	Busan, South Korea	Structure	Rhythm, Repetition

Rhythm was most frequently used as the inspirational musical elements as a design method. This is perhaps due to the fact that many people related rhythm to proportion in previous studies just as the Greeks have used to design buildings. Moreover, this was one of the first techniques that architects have used in incorporating music to architecture. They were mostly expressed on façades or plans. The precedents that involve with rhythms tended to interpret rhythm as proportion.

For instance, Iannis Xenakis designed the window on the west façade of Monastery of La Tourette (figure 3-1)<sup>19)</sup> by calculating the rhythm of «*Meta-stasis*» to proportion. The regularity and the pattern of rhythm were applied on the façade.



[Figure 3-1] Monastery of La Tourette  
Source: (Left)

<http://architectsandartisans.com/index.php/2014/03/le-corbusiers-la-tourette-near-lyon/>  
(Right) <https://graphicnotation.wordpress.com/category/composers/>

Hotel Fouquet (figure 3-2)<sup>20)</sup> expresses the pattern of rhythm on the façade with the placement of modern windows. The rhythm was mostly represented linearly such as Chameleonic Academy. (Figure 3-3)<sup>21)</sup>

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19) Potie, Philippe. *The Monastery of Sainte Marie de La Tourette*. Paris: pour l'ensemble de l'œuvre de Le Corbusier, 2001.

20) ArchDaily, <http://www.archdaily.com/24801/hotel-fouquet-barrier-eduard-fanchanc>. Accessed on May 2016.



[Figure 3-2] Hotel Fouquet

Source:

<http://www.archdaily.com/24801/hotel-fouquet-barrier-eduard-fanchanc>

Carlos Arroyo uses linear panels and even colors as the interpretation of musical pieces such as *«Canon for 36 Voices»* by the 15<sup>th</sup> century Flemish polyphonist Johannes Ockeghem.



[Figure 3-3] Chameleonic Academy

Source: [http://www.a10.eu/magazine/issues/50/chameleonic\\_academy\\_dilbeek.html](http://www.a10.eu/magazine/issues/50/chameleonic_academy_dilbeek.html)

21) New European Architecture, [http://www.a10.eu/magazine/issues/50/chameleonic\\_academy\\_dilbeek.html](http://www.a10.eu/magazine/issues/50/chameleonic_academy_dilbeek.html). Accessed on May 2016.

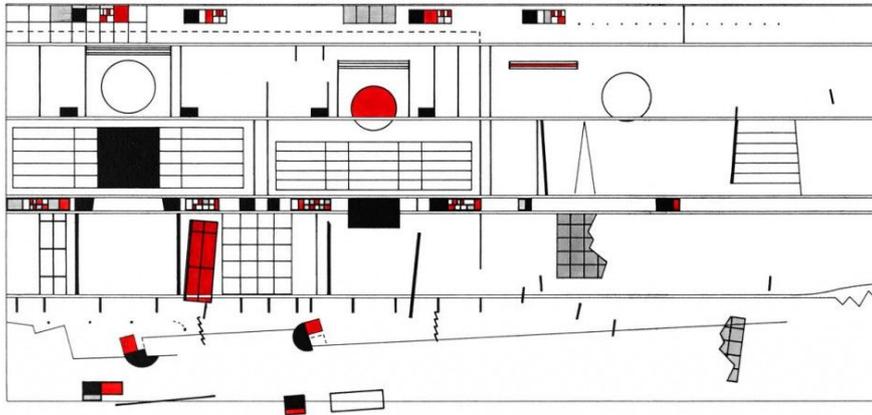
### 3.2.2. Composition

[Table 3-2] Technical Cases - Composition

No.	Name	Architect	Year	Location	Architectural Element	Musical Element
1	Grand Center - St. Louis	Studio Works	1912	Missouri, USA	Programs, Plan	Organization, Clusters, Patterns, Patchwork, Discrete Elements
2	New National Theater	Bernard Tschumi	1986	Tokyo, Japan	Plan	Musical tones, Composition
3	Stretto House	Steven Holl	1992	Texas, USA	Materials, Plan, Section	Score, Instruments, Proportions
4	Kodaly Centre	Epitesz Studio	2010	Pecs, Hungary	Exterior and interior	Proportions, Sequence, Composition
5	Daeyang Gallery and House	Steven Holl	2012	Seoul, South Korea	Façade (Basic geometry)	Music score (blocky and shard-like shapes)
6	Aix en Provence Conservatory of Music	Kengo Kuma and Associates	2013	Aix-en-Provence, France	Façade	Musical Score
7	Beethoven Festspielhaus (Competition)	Jahn	2014	Bonn, Germany	Façade	Musical Score
8	UK Pavilion	Wolfgang Buttress and Tristan Simmonds	2015	Milan Expo, Italy	Form	Composition
9	Tokyo Music Center	Fly Architecture	2015	Tokyo, Japan	Section	Musical Score

The composition and the flow of music were interpreted as material, structure or sequence. They were mostly applied on façade, section or plan. There were precedents that exactly implemented the musical score.

For example, the plan of Bernard Tschumi's New National Theater (figure 3-4)<sup>22)</sup> is divided into eight parts like a manuscript paper, and the programs are arranged based on those guidelines.



[Figure 3-4] Plan Diagram of New National Theater

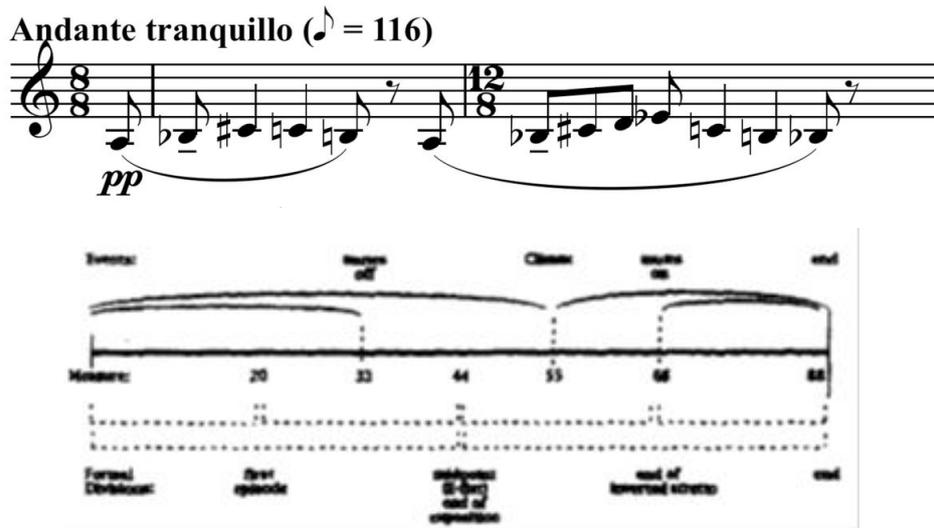
Source:

<http://www.bmiaa.com/concept-notation-bernard-tschumis-retrospective-travels-to-basel/>

Moreover, Stretto House is an example of translating musical score as proportions in the section and composition in plan.<sup>23)</sup> Steven Holl have made the proportion diagram that was derived from the musical score of Bela Bartok's *«Music for Strings, Percussion, and Celesta»*. (Figure 3-5) The rectangular block sections decline in according to the beat, while the roof top structures flow and overlap partially like the notes of the piece. Holl uses many partial overlaps because he wanted to present a fluid sense of movement and continuity in the space in the sequence of the circulation. (Figure 3-6)

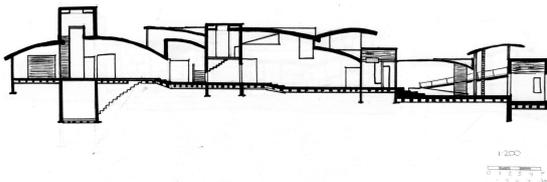
22) Bernard Tschumi Architect, <http://www.tschumi.com/projects/26/#>. Accessed on October 2015.

23) Kim, Young-Hee. A Study on the Relationship between Music and Architecture in the 20<sup>th</sup> Century - With Reference to Time and Space. Journal of Architectural Institute of Korea, 25, 2000.



[Figure 3-5] Diagram from the Musical Score  
Source: (Top)

[http://www.wikiwand.com/en/Music\\_for\\_Strings,\\_Percussion\\_and\\_Celesta](http://www.wikiwand.com/en/Music_for_Strings,_Percussion_and_Celesta)  
(Bottom) Kim, Young-Hee. A Study on the Relationship between Music and Architecture in the 20th Century – With Reference to Time and Space. Journal of Architectural Institute of Korea, 25, 2000.



[Figure 3-6] Overlapping of Stretto House

Source: (Left) <https://strettohouse.wordpress.com/stretto-house-drawings/>  
(Right) <http://www.housegardenspeople.com/2012/01/dallas-modern-homes-tour.html>

### 3.2.3. Sound

[Table 3-3] Technical Cases - Sound

No.	Name	Architect	Year	Location	Architectural Element	Musical Element
1	BMW World	Coop Himmelb(l)au (Wolf Prix)	2010	Munich, Germany	Façade	Chord, glissando
2	Dalian Conference Center	Coop Himmelb(l)au (Wolf Prix)	2012	China	Façade	Chords of music
3	EKKO	Thilo Frank	2013	Hjallerup, Denmark	Structure	Echo
4	The Soundwave Installation	Penda	2015	Xiangyang, China	Pillars	Volume of sound

The precedents that were inspired by sound are expressed with the changing in the harmony of notes applied on the façade, echo of sound on the structure, volume of the music, and etc. These precedents not only include buildings, but also some installations, which allows more creativity and freedom in incorporating musical elements.

In EKKO Installation (figure 3-7), Thilo Frank allures the people to walk through the structure while listening to the sounds of their own voices and footsteps. The structure is made up of 200 wooden frames that are different sizes by twisting the structures. The sound of visitors who visit inside the installation is constantly recorded by hidden microphones in the frames and it is played back through speakers to produce the distorted echo. From far away, the installation creates a visual perception that is superimposed on another set of frames, which also depicts the echo.<sup>24)</sup>

24) Dezeen Magazine. <http://www.dezeen.com/2012/10/29/ekko-installation-by-thilo-frank/>. Accessed on November 2015.



[Figure 3-7] Ekko Installation

Source: <http://www.dezeen.com/2012/10/29/ekko-installation-by-thilo-frank/>

A Chinese firm, Penda, was inspired from Goethe's quotation, "Music is liquid architecture; architecture is frozen music." The Soundwave Installation (figure 3-8) is installed in a park in Xiangyag, China. The installation consists of 500 bright purple fins of pillars that play traditional Chinese music. The pillars are different in heights in order to visualize the increasing and decreasing bars of a digital sound visualizer that symbolizes the volume of music. According to Goethe's quotation, the firm represented the pillars as a frozen moment of a soundwave. The loudness of the music and the brightness of the light are controlled by the motion sensors throughout the installation. It is activated by the movement of the visitors passing by. As the music gets louder, the movement of the pillars gets more vivid, and the light gets brighter.<sup>25)</sup>

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25) Dezeen Magazine.

<http://www.dezeen.com/2015/03/27/penda-purple-pillars-motion-activated-light-sound-soundwave-installation-park-xiangyang-city-china/>. Accessed on November 2015.



[Figure 3-8] The Soundwave Installation

Source:

<http://www.dezeen.com/2015/03/27/penda-purple-pillars-motion-activated-light-sound-soundwave-installation-park-xiangyang-city-china/>

### 3.3. Emotional Cases

#### 3.3.1. Abstraction

[Table 3-4] Emotional Cases - Abstraction

No.	Name	Architect	Year	Location	Architectural Element	Musical Element
1	Rothko Chapel	Mark Rothko	1971	Texas, USA	Interior walls, Color	Transition / Flow
2	Jewish Museum Berlin	Daniel Libeskind	1999	Berlin, Germany	Circulation, Façade	Circularity
3	JS Bach Chamber Music Hall	Zaha Hadid Architects	2009	Manchester, United Kingdom	Structure	Flow
4	Austrian Pavilion	SPAN, Zeytinoglu	2010	Shanghai Expo	Façade	Flow
5	Hotel Liesma	Jevgenijs Busins & Liva Banka	2011	Jurmala, Latvia	Façade	Musical Form, Sounds

The cases that applied emotions with abstraction were more artistically designed than the technical cases. The feeling from the music was expressed with the colors or circulation.

Morton Feldman's music called *«Rothko Chapel »* inspired the interior of the Rothko Chapel. (Figure 3-9) It was composed to be performed in the chapel. Then Rothko changes the movement in the static chapel by using gradation of colors on the walls and using octagon on the plans. Feldman says that, "Rothko's imagery goes right to the edge of the canvas," so he wanted the same effect with the music and make the music to fill in the space of the octagonal-shaped room, and not be heard from a certain distance.<sup>26)</sup>



[Figure 3-9] Interior of Rothko Chapel

Source:

<http://imprint-utk.tumblr.com/post/98978303420/global-spaces-the-rothko-chapel>

Furthermore, Daniel Libeskind's Jewish Museum (figure 3-10) is an example that was designed in order to visualize the image of the music. Libeskind have designed the 'architectural symphony,' the museum with the reinterpretation of

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26) The Guardian, <http://www.theguardian.com/lifeandstyle/2002/feb/01/shopping.artsfeatures1>. Accessed on May 2016.

composition and emotions of music to the composition and emotional image of space. This museum completes Arnold Schonbert's unfinished opera, «*Moses and Aaron*» considering that architecture is one of a symphony piece. The circulation of the building was utilized as the inspiration. The main theme of this opera is representing the Jewish culture and the horror of the holocaust. This takes to the form of this building to be from an abstracted Jewish Star of David that is stretched around the site.<sup>27)</sup>



[Figure 3-10] Jewish Museum  
Source: <http://libeskind.com/works/architecture/>

### 3.3.2. Imagery

[Table 3-5] Emotional Cases - Imagery

No.	Name	Architect	Year	Location	Architectural Element	Musical Element
1	Experience Music Project	Frank Gehry	2000	Washington, USA	Façade, Interior	Rock n' Roll Music, Instrument
2	New Pavilion for the McGill University Schulich School	Saucier + Perrotte architectes	2003	Montreal, QC, Canada	West Façade	Musical figures and rolls of antique

27) Britannica,

[www.britannica.com/biography/Arnold-Schoenberg/images-videos/jewish-museum-berlin-daniel-libeskind-the-music-of-architecture/140788](http://www.britannica.com/biography/Arnold-Schoenberg/images-videos/jewish-museum-berlin-daniel-libeskind-the-music-of-architecture/140788). Accessed on December 2014.

	of Music					mechanical pianos
3	Piano House	Hefei University of Technology	2007	Huainan City, China	Façade	Musical Instrument
4	The House of Music: Denmark	Coop Himmelb(l)au (Wolf Prix)	2009	Aalborg, Denmark	Façade	Unity between music and architecture. Body of instruments = resonance body for the creativity in the House of Music, Notes
5	Chetham's School of Music	Stephenson ISA Studio	2012	Manchester, United Kingdom	Façade (Elevations)	Musical Instrument, Stave
6	Victor McMahon Music Centre	Baldasso Cortese Architects	2014	St. Kevin's College, Australia	Interior	Musical instrument
7	Cantos National Music Center	Allied Works Architecture	2014	Calgary Alberta, Canada	Façade, Programs	Musical Instrument, "Resonant Vessels"
8	House of Hungarian Music	MenoMeno Piu Architects	2015	Budapest, Hungary	Façade	Structural shape of music notes

The cases that applied emotions with imagery were formed by the association of specific materials. The architects have used the musical instruments; music notes stave, and etc. When musical instrument was used in architecture, the architects imitated the form, used the pieces of the musical instrument to get inspiration for design, or conceptually expressed the sound of the instrument into a form.

Frank Gehry's Experience Music Project (figure 3-11) is the two-story atrium that has cyclone-shaped centerpiece made up of 600 guitars and other musical instruments. It is a museum of contemporary popular culture. Gehry was inspired to create a structure that emerges the experience of rock n' roll. He has used several electric guitars, breaks them into pieces, and used them as building blocks for study models. A remix of textures and myriad colors, the exterior of Experience Music Project transmits all the energy and fluidity of music. The three-thousand panels are made of 21 thousand individually cut and shaped stainless steel and painted aluminum shingles, covering the building. Their individual finishes react to different light conditions and appear differently in different angles, reminding the visitors that music and culture is constantly evolving.<sup>28)</sup>



[Figure 3-11] Experience Music Project

Source:

<http://commons.marymount.edu/alrasheedgehry/2015/06/17/experience-music-project/>

Chetham's School of Music (figure 3-12) uses musical instrument as an inspiration for the façade design. Strip windows wrap the curved corners of the building, while lintels that pop out create heavy horizontal stripes. Stephenson ISA Studio states that the form of the building reflects the curved forms of musical instruments and the elevations are expressed horizontally, which is

<sup>28)</sup> EMP Museum, <http://www.empmuseum.org/about-emp/the-emp-building.aspx>. Accessed on December 2014.

inspired by the musical stave and pianola.<sup>29)</sup>



[Figure 3-12] Chetham's School of Music

Source:

<http://www.dezeen.com/2013/07/02/chethams-music-school-by-stephenson-isa-studio/>

Lastly, the proposal of Cantos National Music Center (figure 3-13) integrates the historic King Edward Hotel, a legendary house of blues, and it is a new kind of space that the Cantos Music Foundation has ever designed. This project takes responsibility of the first step of the redevelopment of Calgary's East Village and the establishment of a new music district in the historic heart of the city. Conceptually, the project began with the idea of "resonant vessels" or instruments orchestrated by the collections and programs of the building. The body of the building is designed and detailed with the inspiration of the instrument cases, while the forms of the interior are freer which is influenced by acoustics.<sup>30)</sup>

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29) Dezeen Magazine. <http://www.dezeen.com/2013/07/02/chethams-music-school-by-stephenson-isa-studio/>. Accessed on February 2016.

30) ArchDaily. <http://www.archdaily.com/36358/national-music-center-allied-works>. Accessed on May 2016.



[Figure 3-13] Cantos National Music Center

Source:

<http://worldarchitecture.org/architecture-news/chcpn/national-music-centre-of-canada-calgary-2009-a-top-level-summit.html>



## **Chapter 4 Research Method**

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**4.1. Survey Purpose and Method**

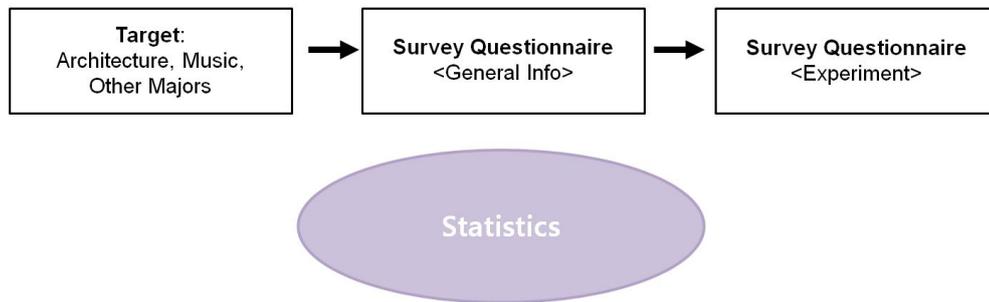
**4.2. Survey Contents**

**4.3. Analysis Method**

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#### 4.1. Survey Purpose and Method

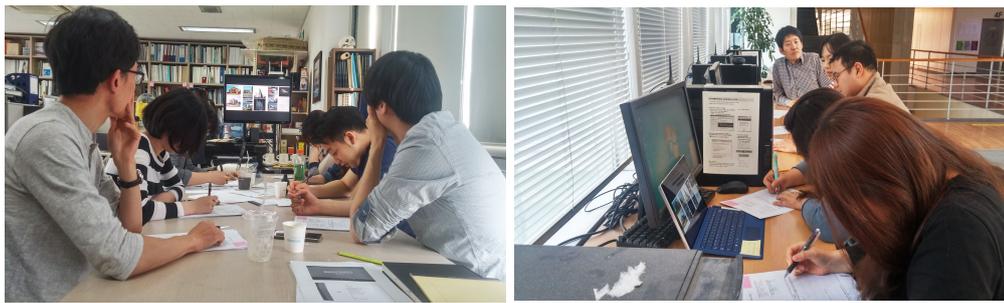
In the previous chapter, there were various methods of applying musical elements to the architectural designs. However, all the preceding studies of music and architecture were theoretical and superficial. There were no empirical studies that study in details about the perceptions of the visitors. Therefore, this research will observe statistically on how people perceive the musical characteristics from musically inspired architecture through the survey questionnaire as the method of this research. (Figure 4-1)



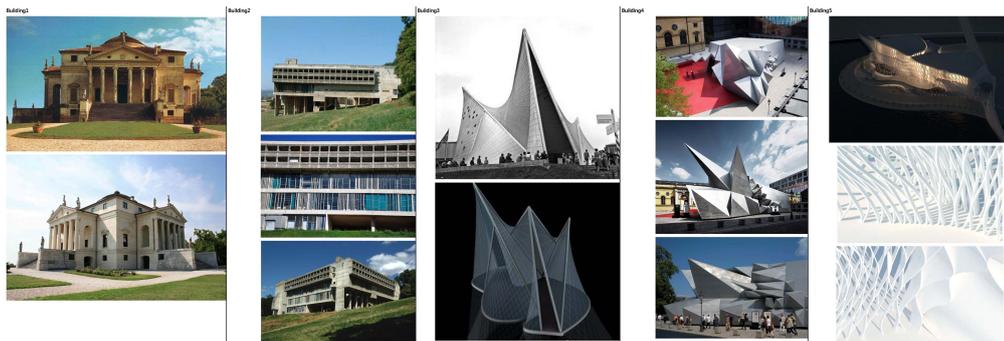
[Figure 4-1] Survey Method

The target of this survey is people who have or are majoring in architecture, music or any other fields in order to see if architecture majors or music majors can identify the musical properties more than the other majors. In the general information on the questionnaire, (appendix) it asks about the basic information such as age, gender, major, final education, average duration of listening to music per day, music genre preference and music experience. Then, in the experiment section of the questionnaire, the pictures of five musically inspired buildings including elevation view and perspective views are shown all at once to the respondents (figure 4-3), and five songs were played one at a time out of order. Each of the songs is cut to two minutes and thirty seconds for consistency of the survey. The respondents were allowed to listen to the music

more than once if they need to. The respondents were asked to match the music with a building that they think they correlate to each other, and write a short answer on the reason why they chose such answer. They were not allowed to select more than one building on a song. Then, all the responses from the respondents were analyzed statistically. The specific information on the buildings and songs are in the following section 4.2. (Table 4-1)



[Figure 4-2] Survey Method



[Figure 4-3] Pictures of the Five Buildings

## 4.2. Survey Contents

For the survey, five different buildings that were musically inspired were selected. The standard of selection was the buildings that applied rhythm, and the buildings that the architects have directly mentioned on the application of

music. Rhythm and architecture are similar in terms of property for the fact that it has the proportions and ratio. Also, rhythm has a systematical order as it is in architecture. The case analysis has shown that rhythm was frequently used by the architects from the past. Thus, it was predicted that the respondents will be able to recognize the rhythm more than any other musical elements.

[Table 4-1] Survey Contents

No.	Name	Architect	Year	Location	Music Title	Composer
1	Villa La Rotonda	Palladio	1570	Italy	<i>Palladio</i> <sup>31)</sup> (Music 4)	Karl Jenkins
2	Monastery of La Tourette	Le Corbusier, Iannis Xenakis	1957	France	<i>Meta-stasis</i> <sup>32)</sup> (Music 5)	Iannis Xenakis
3	Philips Pavilion	Iannis Xenakis	1958	Belgium	<i>Poeme Electronique</i> <sup>33)</sup> (Music 1)	Edgar Varese
4	Pavilion 21 MINI Opera Space	Coop Himmelb(l)au	2013	Germany	<i>Purple Haze</i> <sup>34)</sup> (Music 2)	Jimi Hendrix
5	Busan Opera House (proposal)	Orproject	2014	-	<i>Klavierstück</i> <sup>35)</sup> (Music 3)	Karlheinz Stockhausen

Unlike the other four buildings, Building 1, Villa La Rotonda (figure 4-4) by Andrea Palladio, was built first, and then the composer, Karl Jenkins, has composed the piece, «*Palladio*» according to Villa La Rotonda's Renaissance style building. As noted in the description of his album<sup>36)</sup>, the title of the piece

31) Youtube. <https://www.youtube.com/watch?v=Mqmbz8W1-tA>. Accessed on September 2015.

32) Youtube. <https://www.youtube.com/watch?v=SZazYFchLRI>. Accessed on September 2015.

33) Youtube. [https://www.youtube.com/watch?v=\\_3cKxLxq-Xw](https://www.youtube.com/watch?v=_3cKxLxq-Xw). Accessed on September 2015.

34) Youtube. <https://www.youtube.com/watch?v=fjwWjx7Cw8I>. Accessed on September 2015.

35) Youtube. <https://www.youtube.com/watch?v=pEMs-pCA5LY>. Accessed on September 2015.

36) Boosey & Hawkes. [http://www.boosey.com/pages/cr/catalogue/cat\\_detail.asp?site-lang=en&musicid=761&langid=1](http://www.boosey.com/pages/cr/catalogue/cat_detail.asp?site-lang=en&musicid=761&langid=1). Accessed on June 2016.

was in reverence of Palladio. Jenkins was inspired by the building's harmony of proportion and order. Therefore, he translated that in the music with harmonious chords, repetitive patterns (figure 4-5) like the rhythm and in composition. (Figure 4-6)<sup>37)</sup>



[Figure 4-4] Villa La Rotonda

Source:

<http://faculty.etsu.edu/kortumr/HUMT2320/highrenaissance/htmdescriptionpages/villarotunda.htm>



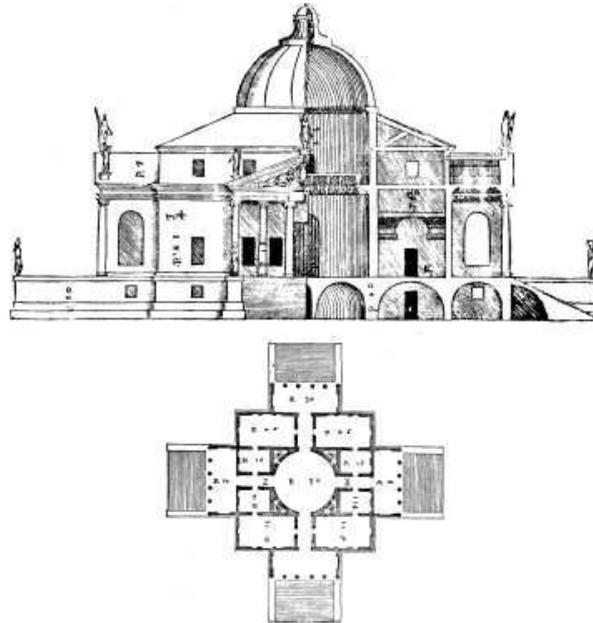
[Figure 4-5] Repetition in Villa La Rotonda

Source: <http://www.10cose.it/vicenza/cosa-vedere-vicenza>

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37) The Culture Concept Circle.

<http://www.thecultureconcept.com/circle/music-harmony-from-apollo-to-palladio-mozart-to-jenkins>. Accessed on September 2015.



[Figure 4-6] Composition of Villa La Rotonda

Source:

[https://en.wikipedia.org/wiki/Palladio\\_\(Jenkins\)](https://en.wikipedia.org/wiki/Palladio_(Jenkins))

For Building 2, Monastery of La Tourette (figure 4-5) was initially designed by Le Corbusier and Iannis Xenakis worked as engineering assistant at first at Corbusier's studio. However, Xenakis rapidly started to be responsible for more important tasks, and eventually collaborated with Corbusier on major projects like this building. While working for his studio, Xenakis proposed his own notation system relating to music stating that "this is the twentieth century's evolution of architecture," which led him to introduce the rhythmical order in this building.<sup>38)</sup>

The Foundation of Le Corbusier mentions the principle behind the design that Iannis Xenakis has done.<sup>39)</sup> Out of all the work in this building, Xenakis

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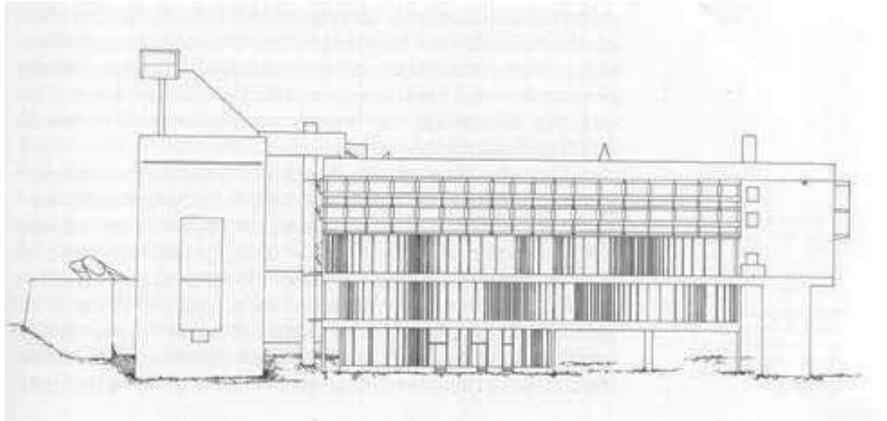
38) Iannis Xenakis Architecture, <http://www.iannis-xenakis.org/xen/archi/architecture.html>. Accessed on May 2016.

39) Le Corbusier and Foundation of Le Corbusier, *La Tourette and Other Buildings and Projects, 1955-1957*, Garland Pub.; Paris: Foundation Le Corbusier, New York, 1984.

especially worked on the placement of the vertical elements for the strip windows on the western façade of the building, which he called it the “undulatory glass surfaces.” (Figure 4-6) By using modules, he gave changes in the pattern in the windows, and made the width of the window asymmetrical intervals in order to reveal the movement in horizontal. The idea of “decreasing-increasing” of intervals of the vertical strip windows came from the composition, *«Meta-stasis»*, an orchestral work for 61 musicians. Xenakis has worked on this composition with the law of proportion and mathematical probability as he was working on the design for the building. It is defined by the extraordinary and debut implementation of glissandi within a composition. The motif of the façade and the composition design is the glissandi (plural of glissando), the sliding movement within the tonal scale, for instance with a string instrument. This is represented by the changes in the density of pattern of the glass window. (Figure 4-7) This is also to express the “undulatory glass surfaces” with the undulating density. For the measurement of the façade division, minimum and maximum can be identified, in other words the points of the largest and lowest density in the façade system, as well as the distances between them. The increase-decrease of the façade intervals is set equal to the increase-decrease of notes along the tonal scale. The largest distance equals the lowest note; the smallest distance equals the highest note.<sup>40)</sup>

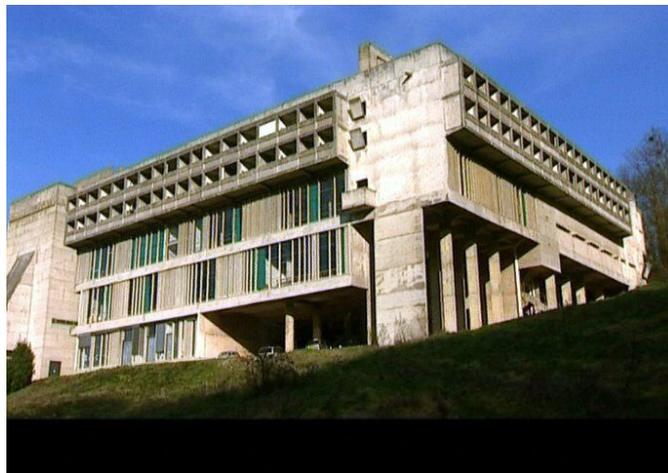
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40) Xenakis-emulator, [http://nexialist.com/XENAKIS/NEX\\_XENAKIS.htm](http://nexialist.com/XENAKIS/NEX_XENAKIS.htm). Accessed on September 2015.



[Figure 4-7] Elevation Drawing of Western Façade

Source: <http://klangwerkstatt.net/latourette.htm>



[Figure 4-8] Monastery of La Tourette

Source: <https://archdialog.com/tag/unite-d-habitation-reze/>

Building 3, Philips Pavilion (figure 4-7) was World's Fair pavilion designed for Expo '58 in Brussel, Belgium by the office of Le Corbusier. It was the first World's Fair since the end of World War II. This World Fair was famous for combining music with architecture creating a gestalt through an experiential encounter where body meets sound and space. When this building was commissioned by the electric company called Philips, Le Corbusier replied by

stating,

“I will not make a pavilion for you but an Electronic Poem and a vessel containing the poem; light, color image, rhythm, and sound joined together in an organic synthesis.”<sup>41)</sup>

However, with the busy schedule of Le Corbusier, Xenakis took over much of the project management. Xenakis wrote on his book about the process of creating the pavilion.<sup>42)</sup> The pavilion is a cluster of nine hyperbolic paraboloids (figure 4-10) made out of reinforced concrete with precast panels hung in tension from wire cables in which music, Edgar Varese’s *«Poeme Electronique»* has created the space by sound projectionists using 425 megaphones. It was the first electronic-spatial environment to combine architecture, film, light and music to a total experience made to functions in time and space. All the shells are hyperbolic paraboloids truncated at the ground, except the three above and three shells of entry and exit. The basic guidelines given to both Xenakis and Varese were that the interior was to be shaped in a manner similar to the stomach of a cow, with the form coming from a basic mathematical algorithm. The complex and connected form of the pavilion was created from the glissando with lines and curves. Xenakis has represented the glissando by the ascending glissando line and the line of descending glissando becoming the form of conoid by the density of the changes.<sup>43)</sup>

41) CodeHop, <http://codehop.com/edgard-varese-and-le-corbusier-poeme-electronique/>. Accessed on May 2016.

42) Xenakis, Iannis. *Formalized Music: Thought and Mathematics in Composition*. Hillsdale: Pendragon Press, 1992.

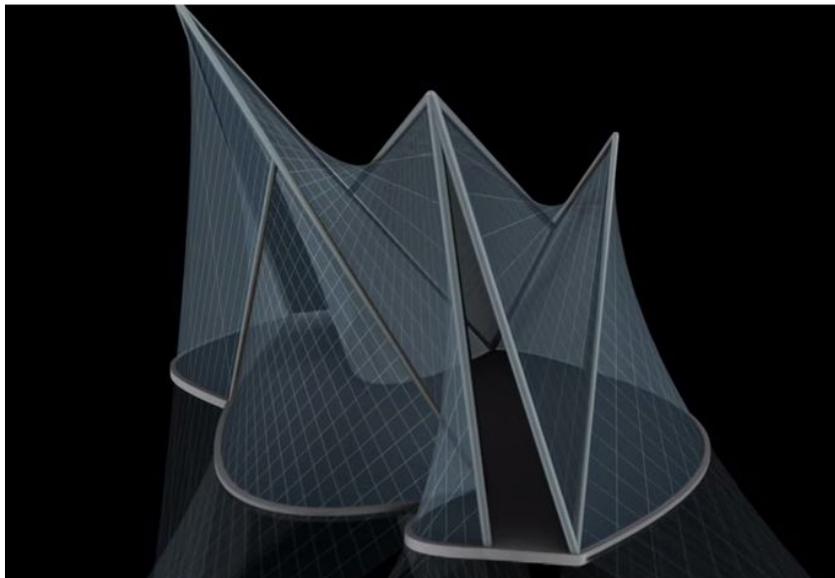
43) Lee, Hong-Kyu, Park, Jin-Ho, Dong Jung-Keun. A Study on the Form of his Philips-pavilion based on Xenakis's the Musical Thought. *Journal of Architectural Institute of Korea*, 25(3), 2009.



[Figure 4-9] Philips Pavilion

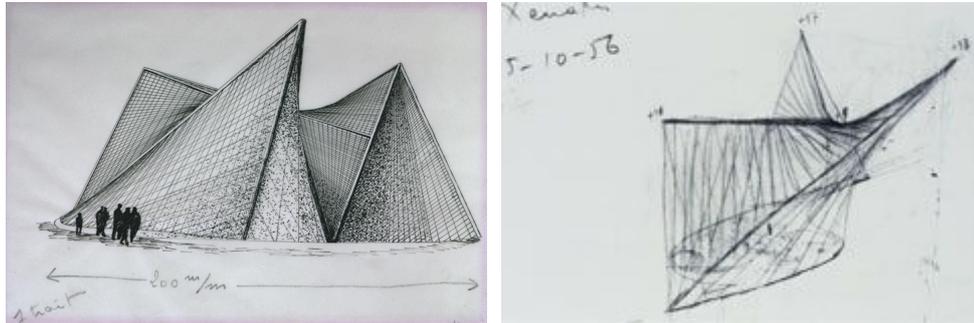
Source:

<http://www.archdaily.com/157658/ad-classics-expo-58-philips-pavilion-le-corbusier-and-iannis-xenakis>



[Figure 4-10] Nine Hyperbolic Paraboloids

Source: [https://www.youtube.com/watch?v=\\_3cKxLxq-Xw](https://www.youtube.com/watch?v=_3cKxLxq-Xw)



[Figure 4-11] Sketches of Xenakis  
Source: [www.iannis-xenakis.org](http://www.iannis-xenakis.org)

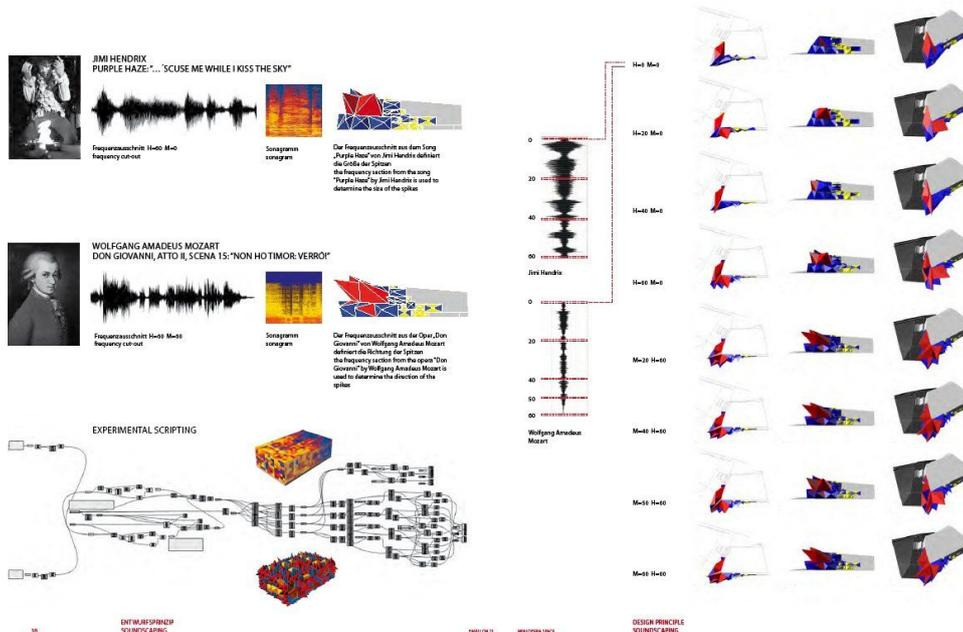
Building 4, the Pavilion 21 MINI Opera Space, (figure 4-12) is a temporary mobile performance space for the Bavarian State Opera in Munich, Germany. Wolf D. Prix, the head of Coop Himmelb(l)au states that it is intended to be used for a variety of events at the annual Opera Festival 2010 and then to travel to other various locations by reassembling. The form of the pavilion was driven by the concept of materializing music into architecture.<sup>44)</sup> Selected sequences of songs become forces that transform and create spatial form. The sequence of Jimi Hendrix's *«Purple Haze»* was utilized, “Scuse me while I kiss the sky” by analyzing the frequencies of the sound file and linking it to the computer generated 3D model, the scripting tool then parametrically transforming the shell into pyramid shapes like spikes.<sup>45)</sup> (Figure 4-13)

44) Coop Himmelb(l)au Wolf D. Prix & Partner,  
<http://www.coop-himmelblau.at/architecture/projects/pavilion-21-mini-opera-space>. Accessed on November 2015.

45) ArchDaily, <http://www.archdaily.com/41319/pavilion-21-coop-himmelblau>. Accessed on May 2016.



[Figure 4-12] Pavilion 21 MINI Opera Space  
Source: <http://architazer.com/projects/pavilion-21-mini-opera-space/>



[Figure 4-13] Process in Generation of 3D Model  
Source:

<http://www.coop-himmelblau.at/architecture/publications/pavillon-21-mini-opera-space>

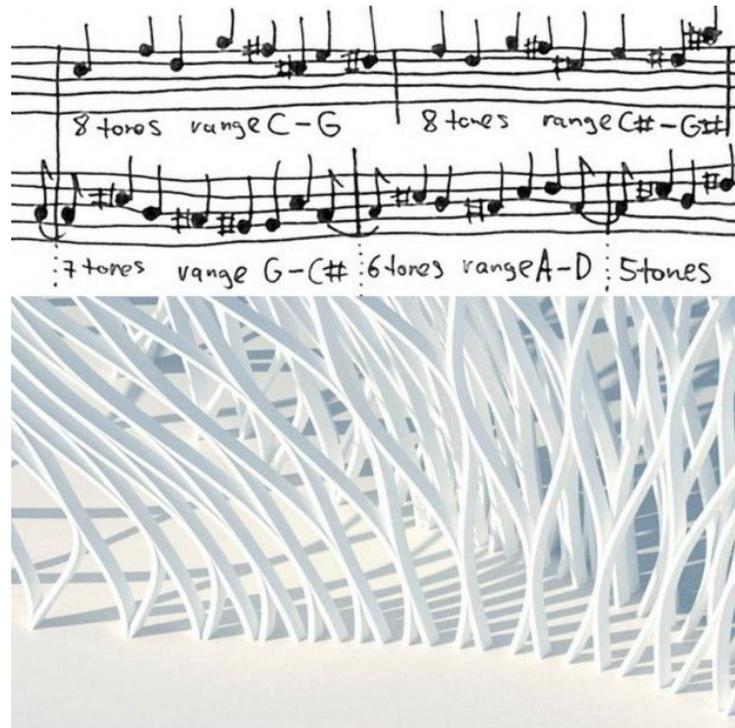
Building 5 is Orproject's proposal of Busan Opera House (figure 4-14) in Busan, South Korea. According to the scheme of the opera house, Orproject describes that the design for the Busan Opera House is based on simple strip morphology instead of a twelve tone row, which creates the façade, structure and rhythm within itself. The repetition exists in space instead of time. The façade structure is formed by the layers of the strips, and the patterns that shift and alter create complex architectural rhythms. This structure is used to control the view, light and shading properties of the façade. Orproject began with the idea that Busan Opera House becomes the physical manifestation of *«Klavierstück I»*, like a frozen music. This piece uses a twelve tone row, and starts with the lowest key of the piano. After the first cycle the row gets repeated, though shifted up by a half tone. (Figure 4-15) In the next repetition this shift continues, but the range now also gets reduced in its size. For instance, the lowest tone gets translated up by one octave again, and the second lowest tone gets dropped out, so that only the remaining eleven tones of the row are played. The range of the twelve tone row continues to be reduced and shifted upwards until only one tone is left in each repetition of the original row. Then the range grows again, and still moving upwards goes through further modulations. The different voices of the piece starts to separate, the size of the different parallel ranges begins to diverge, they move around each other, until finally they grow together again, still moving up and their range fading out with the highest key of the piano. The flow of the façade layers is also influenced by the programs which they enclose. As an effect of this the layers split up at certain points, and after forming a coherent system with the overlay of its rhythms, the individual layers separate and their individual patterns become visible.<sup>46)</sup>

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46) Orproject, <http://orproject.com/busanoperahouse/>. Accessed on November 2015.



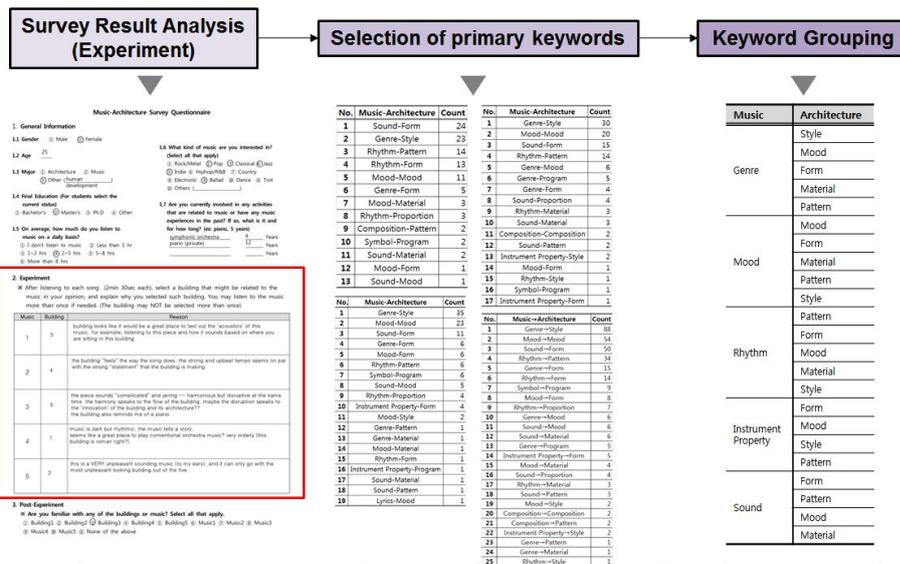
[Figure 4-14] Busan Opera House (Orproject)  
Source: <http://wordlesstech.com/busan-opera-house-by-orproject/>



[Figure 4-15] Strip Morphology  
Source: <http://wordlesstech.com/busan-opera-house-by-orproject/>

### 4.3. Analysis Method

The method of analysis shows the steps of analyzing with all the gathered information from the survey questionnaire responses. The general information is all statistically analyzed by representing in tables and graphs in order to see the data at a glance. The data is organized by the number of people or percentage by majors or number of correct answers. This is to make several comparisons such as if gender matters, if there is any differences in studying in different fields, if average number of hours of listening to music per day matters, if there is any other effect with the people who have made more correct answers, or if the duration of musical experience help in selecting the correct answers. Then, examining the reasons that the respondents have matched such songs will help to draw primary keywords related to musical elements and architectural factors that frequently appeared. Those keywords are to be organized and analyzed by the frequency to see how people perceive music in architecture. (Figure 4-15)



[Figure 4-16] Analysis Method



## **Chapter 5 Result of Survey Analysis**

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### **5.1. Survey Results**

### **5.2. Keyword Selection and Grouping**

5.2.1 Keyword Frequency

5.2.2 Interpretation

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## 5.1. Survey Results

From January to March 2016, 50 people of architecture majors, 50 people of music majors, and 50 people of the rest of the majors, a total of 150 people have responded to the survey questionnaire. (Table 5-1) The survey was taken directly and electronically such as email in groups and individually. The responses were all statistically organized in order to analyze and see the results more conveniently at once. The following tables and figures show the results.

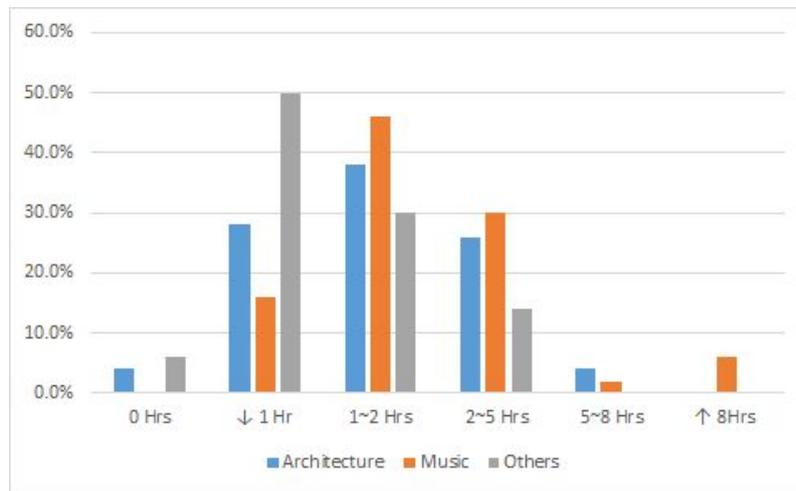
[Table 5-1] Number of Respondents

	Male	Female	Total
<b>Architecture</b>	26	24	50
<b>Music</b>	15	35	50
<b>Others</b>	16	34	50
<b>Total</b>	57	93	150

The average time of listening to music per day (table 5-2) shows that architecture majors mostly listen to the music 1~2 hours per day, music majors listen to the music for 1~2 hours and other majors listen to the music less than an hour daily. Overall, most of the people listen to music for 1~2 hours. The music majors were listening to the music the most out of all the majors. All of the music majors were listening to the music daily, and three of them were listening to the music more than 8 hours a day. From this information, it can be assumed that music majors may be able to match the buildings with the correct music the most since they are exposed to the music more often which they will have ability to listen to the music more carefully and determine its properties better along with their background of having more musical knowledge.

[Table 5-2] Average Time of Listening to Music Per Day by Majors

	0 Hrs	↓ 1 Hr	1~2 Hrs	2~5 Hrs	5~8 Hrs	↑8Hrs	Total
<b>Architecture</b>	2	14	19	13	2	0	50
<b>Music</b>	0	8	23	15	1	3	50
<b>Others</b>	3	25	15	7	0	0	50
<b>Total</b>	5	47	57	35	3	3	150
<b>Percentage</b>	3%	31%	38%	23%	2%	2%	100%



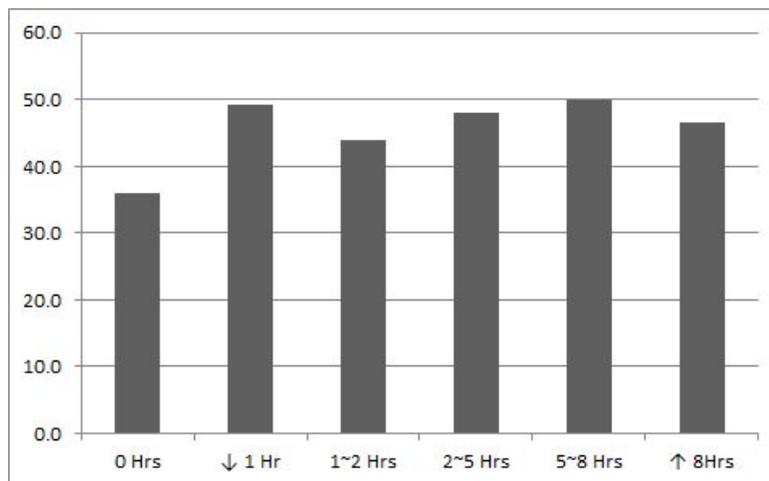
[Figure 5-1] Average Time of Listening to Music Per Day by Majors

Moreover, the average time of listening to music per day and the number of correct answers are compared. Correct answer means that the respondent has matched the music and building correctly disregarding the reasons. Table 5-2 presents that the respondents who have matched all five of the buildings and music did not listen to the music the most out of all the respondents. None of them listen to the music more than 8 hours a day, and only one respondent listened to the music 5~8 hours. One of the respondents even did not listen to music at all. Most of the respondents who have matched all five answers correctly listened to fair amount of music daily. On the other hand, only two of

the respondents who did not make any correct answers did not listen to music at all and the rest of them listened to music daily. Figure 5-1 shows visually that there were no correlations between the field of study and the time of listening to music per day.

[Table 5-3] Average Time of Listening to Music Per Day by Number of Correct Answers

# of Hrs # of Answers	0 Hrs	↓ 1 Hr	1~2 Hrs	2~5 Hrs	5~8 Hrs	↑ 8Hrs	Total
5	1	7	6	7	1	0	22
3	0	16	15	8	0	2	41
2	2	12	16	8	2	0	40
1	0	11	14	9	1	1	36
0	2	2	4	3	0	0	11
<b>Total</b>	5	48	55	35	4	3	150



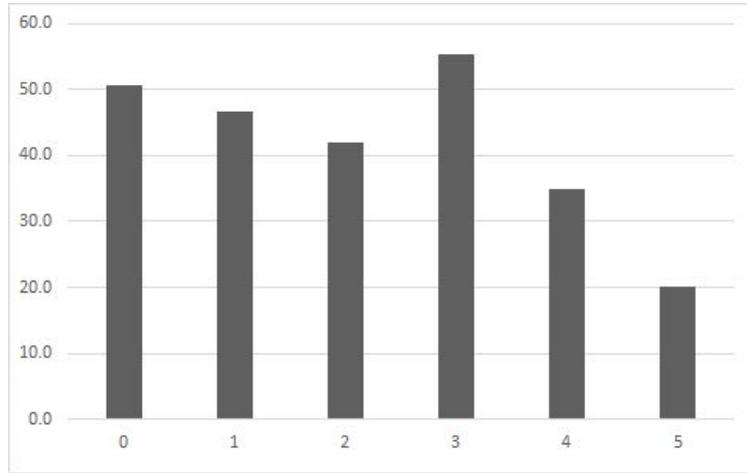
[Figure 5-2] Average Time of Listening to Music Per Day by Number of Correct Answers

Then the number of experience in music was analyzed by the number of

correct answers due to the fact that the respondents who are not music majors may also have more variety of musical backgrounds that might have affected the results. The experience in music can be defined as having experiences taking musical lessons, participating in orchestra or band or any experience that involves any kinds of musical activities such as composing, singing, playing musical instruments, and etc. Moreover, the number will be counted by the different kinds of experiences. If the hypothesis was that the respondents who have the most number of experience in music, in this case five, would match all five of the buildings with correct music. However, figure 5-3 shows that the respondents with five experiences in music had the least amount of correct answers. Table 5-4 also shows that none of the respondents who have five experiences in music received all correct answers. Instead, one respondent with five musical experiences has received one correct answer, and four respondents who did not have any musical experience have matched all the buildings and music correctly. Therefore, this data also reveals that there are no correlations between the number of experience in music and the number of correct answers.

[Table 5-4] Number of Experience in Music by Number of Correct Answers

# of Years # of Answers	0	1	2	3	4	5	Total
5	4	7	7	3	1	0	22
3	9	19	6	7	0	0	41
2	11	13	12	4	0	0	40
1	2	15	13	3	2	1	36
0	2	3	5	0	1	0	11
<b>Total</b>	28	57	43	17	4	1	150

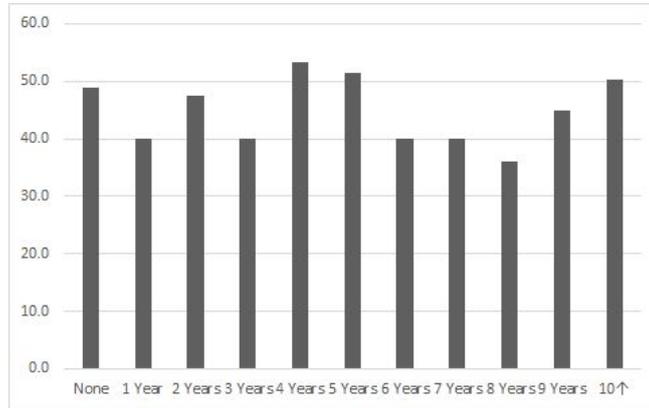


[Figure 5-3] Number of Experience in Music by Number of Correct Answers

Instead of the number of the musical experience, the duration of the experience in music may have affected the results because the respondents who have focused on certain musical experience for a longer time may have more knowledge in music to listen to the music more carefully and match the buildings more correctly with the music. However, table 5-5 and figure 5-4 show that all the respondents with different amount of experience in music had similar percentage of matching the buildings and music correctly, which also leads to the fact that this data does not affect the results as well.

[Table 5-5] Duration of Experience in Music by Number of Correct Answers

# of Years # of Answers	0	1	2	3	4	5	6	7	8	9	10↑	Total
5	3	1	1	1	1	1	0	0	0	1	13	22
3	9	2	3	2	1	4	3	2	2	3	10	41
2	11	2	1	4	4	0	0	0	5	0	14	41
1	2	3	3	3	0	1	1	2	2	4	15	36
0	2	1	0	1	0	1	1	0	1	0	3	10
<b>Total</b>	27	9	8	11	6	7	5	4	10	8	55	150

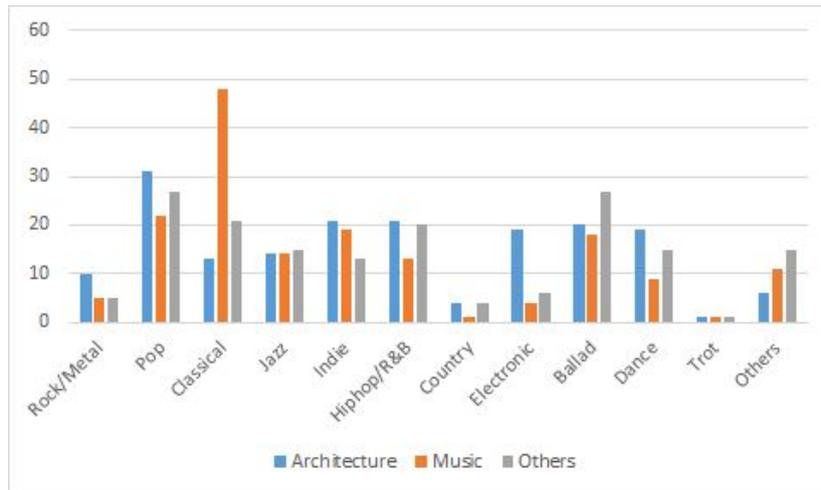


[Figure 5-4] Duration of Experience in Music by Number of Correct Answers

Respondents' interested music genres were analyzed by majors. The only noticeable data is that the music majors particularly were interested in classical music. (Figure 5-5) This is in the result of the music majors mostly studied the classical music. There were no other genres that had notable differences in between the majors. Other than the fact that rock/metal, country and trot music were the least interested genres, other genres were all fairly similar in numbers.

[Table 5-6] Interested Music Genre by Majors

Genre Major	Rock / Metal	Pop	Classical	Jazz	Indie	Hiphop / R&B	Country	Electronic	Ballad	Dance	Trot	Others
Architecture	9	31	13	15	21	21	4	19	20	18	1	7
Music	4	22	48	14	19	13	1	4	18	8	1	12
Others	4	27	21	15	13	20	4	6	27	15	1	16
<b>Total</b>	<b>17</b>	<b>80</b>	<b>82</b>	<b>43</b>	<b>53</b>	<b>54</b>	<b>9</b>	<b>29</b>	<b>65</b>	<b>43</b>	<b>3</b>	<b>35</b>

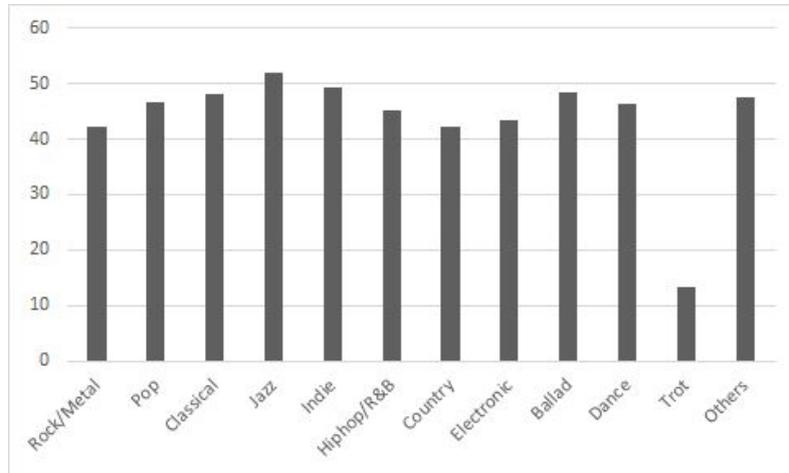


[Figure 5-5] Interested Music Genre by Majors

Since there were no genres that each major were particularly interested in, the number of correct answers may have affected the result. Table 5-7 and Figure 5-6 present that the respondents who were interested in trot had the least percentage of making the correct match. However, this may not be reliable because there were only 3 respondents who were interested in trot.

[Table 5-7] Interested Music Genre by Number of Correct Answers

Genre # of Answers	Rock / Metal	Pop	Classical	Jazz	Indie	Hiphop / R&B	Country	Electronic	Ballad	Dance	Trot	Others
5	1	13	13	8	10	6	0	4	10	6	0	5
3	5	18	20	13	15	15	4	4	18	12	0	10
2	5	26	25	12	13	17	2	12	20	9	0	10
1	6	16	22	11	10	13	3	7	13	11	2	8
0	0	7	2	0	5	3	0	2	4	3	1	2
<b>Total</b>	17	80	82	44	53	54	9	29	65	41	3	35

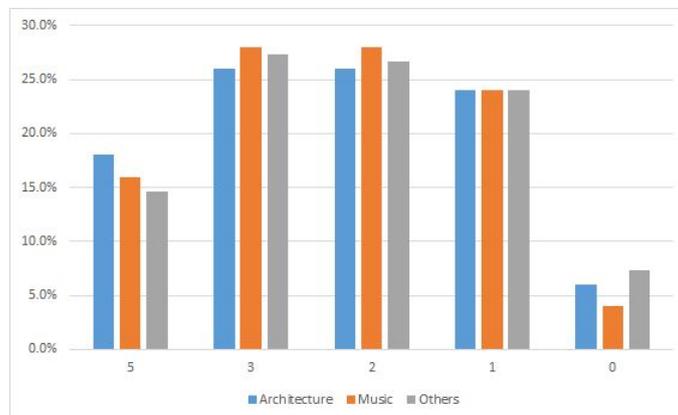


[Figure 5-6] Interested Music Genre by Number of Correct Answers

Then the number of answers is analyzed by the majors. Like the other results, this data did not have a correlation with each other. In table 5-8, the expected value, the percentage of randomly matching the correct buildings and music, shows that only 0.8% of the respondents were supposed to match all the five buildings correctly and 36.7% of the respondents were supposed to make all incorrect matches. The expected value increased as the number of correct answers decreased. However, the actual results (table 5-8) came out to be that the respondents made more correct answers than the expected value. When expected value was 0.8% for matching all five of the buildings correctly with the music, the 15% of the respondents made the correct answers. Moreover, with the expected value of 36.7% in making all the answers incorrectly, the actual result came out to be only 7% of the respondents. This result may vary slightly depending on the number of the respondents. However, this result reveals that people actually perceive the musical qualities from musically inspired buildings.

[Table 5-8] Number of Answers by Majors

# of Answers \ Major	5	3	2	1	0	Total
Architecture	5	14	13	12	6	50
Music	9	13	13	12	3	50
Others	8	14	14	12	2	50
<b>Total (#)</b>	22	41	40	36	11	150
<b>Total (%)</b>	14.6%	27.3%	26.7%	24.0%	7.3%	100%
<b>Expected Value (%)</b>	0.8%	8.3%	16.7%	37.5%	36.7%	100%



[Figure 5-7] Number of Answers by Majors

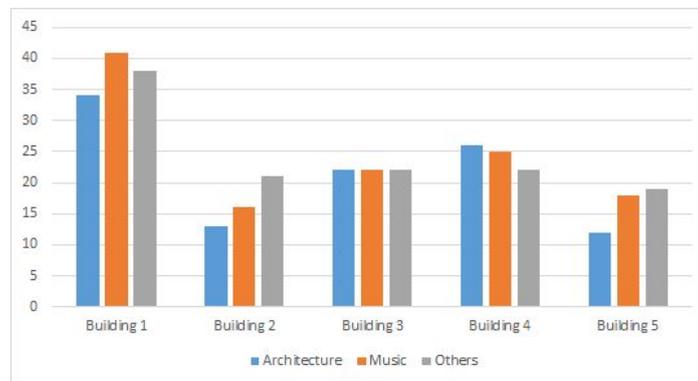
Out of the five buildings, the results have shown that the respondents have correctly matched the building 1, Villa La Rotonda, the most with 113 respondents out of 150 respondents. (75.3%) (Table 5-9) Less than half of the respondents have matched the rest of the buildings correctly. (Figure 5-8) According to the respondents’ reasons on why they have chosen building 1, most of the respondents have mentioned that,

“The music has a classical feel to it like the building.”

This may be due to the fact that building 1 has a definite building style with the definite genre of music. Moreover, a large number of the respondents have associated the music and the building with the certain period of time. Unlike this building, the rest of the buildings had more variety of reasons.

[Table 5-9] Correct Answers in Each Building

	Building 1	Building 2	Building 3	Building 4	Building 5
<b>Architecture</b>	34	13	22	26	12
<b>Music</b>	41	16	22	25	18
<b>Others</b>	38	21	22	22	19
<b>Total</b>	113	50	66	73	49



[Figure 5-8] Correct Answers in Each Building

## 5.2. Keyword Selection and Grouping

### 5.2.1. Definition of Keywords

As mentioned in the analysis method (4.3), keywords are extracted directly from the responses of the respondents. The responses are concentrated on the second part of the survey questionnaire, the matching of the buildings and songs and explaining the reasons why the respondents have selected such buildings

and songs. From that information, the words, phrases or expressions that were frequently mentioned are gathered by the frequency. Then, the similar ones are grouped into a keyword, which came out to be four keywords in music, genre, mood, rhythm and sound, and five keywords in architecture, style, mood, pattern, form and material. (Table 5-10)

[Table 5-10] Definition of Keywords

Category	Keyword	Definition
Music	Genre	Genre, Period
	Mood	Emotions, Feelings, Symbolization, Imagery
	Rhythm	Regularity, Sequence, Repetition, Speed, Composition, Structure
	Sound	Sound description (instrument), Volume, Pitch, Notes, Harmony
Architecture	Style	Style, Period
	Mood	Emotions, Conception, Feelings, Program, Function
	Pattern	Regularity, Repetition, Composition, Structure, Size, Proportion
	Form	Shape
	Material	Material, Technique

First, genre in music is the genre or types of music and music that was created or played in the certain period of time that respondents have mentioned such as rock music, electronic music, religious music, modern music, contemporary music, classical music, and etc. Mood is the emotions and feelings that the respondents have received listening to the song. For instance, the respondents have gotten terrified by listening to the song, gotten a cold feeling from the song, felt peaceful, and etc. Moreover, the respondents have symbolized and made imageries such as linear music, a music that might be played in a concert hall, music feeling like the universe, and etc. Rhythm includes the regularity, sequence, speed, composition, and structure. For example, music having constant beat, repetitive rhythm, irregular beats, strong beats, fast rhythm, the flow of the whole music and etc. Sound in music is the

description of sound such as instrument, volume, pitch, and harmony of notes. This is when the respondents describe the song as sharp sound, ascending notes, sound of bells, electric guitar and piano, and etc.

In architecture, style is the types of architectural style and the style that represents certain period of time such as Renaissance, classic and contemporary architecture, and etc. Mood from architecture emerges from emotions, making conception, feelings, and imagining and associating the building's function and program. For example, a building that gives intimidating feeling, a building looking like a concert hall, school or church, a building looking like it is going to rend the skies, and etc. The pattern of architecture is the regularity, repetition, composition, structure, size and proportion of the buildings such as mentioning about the intervals of the windows, irregular pattern of the structure, the repetitive windows, and etc. The form of the architecture means the shape of the building. The respondents have described the building as sharp, linear, rectangular, a shape of a bell, cylinder and etc. The material of the architecture is describing the material and technique that might have used to build the building such as concrete, metal, steel, the building's detailed technique and etc.

### **5.2.2. Keyword Frequency**

Instead of analyzing the correctly matched responses and the incorrectly matched responses separately, the responses are analyzed as a whole by each major to see what kinds of elements are perceived by the majors. This is due to fact that the respondents who have correctly matched the buildings and songs did not match up with the architects' intentions. On the other hand, even when the respondents have matched incorrectly, the reasons for selection was very similar to the architects' intentions. The keywords from the responses of all the majors are listed in the order of frequencies from highest to lowest.

[Table 5-11] Keywords from the Response of Architecture Majors

No.	Music-Architecture	Count
1	Mood-Mood	46
2	Rhythm-Pattern	38
3	Sound-Form	36
4	Genre-Style	30
5	Rhythm-Form	21
6	Mood-Form	18
7	Sound-Mood	9
8	Sound-Pattern	9
9	Genre-Form	6
10	Mood-Pattern	4
11	Genre-Mood	4
12	Sound-Material	3
13	Mood-Material	3
14	Rhythm-Mood	2
15	Genre-Material	2
16	Mood-Style	1

The architecture majors have associated the mood of music with the mood of the architecture the most, stating that frightening music (music 5) matches with scary looking building in building 2. (Table 5-11) Secondly, they have associated the musical rhythm with the pattern in architecture along with musical sound to architectural form with the difference of two. When the respondents have interpreted the rhythm to pattern, they mentioned that the rhythm of the song (music 5) was related to the proportions of the windows in building 2. For sound and form, the sound of the electric guitar in music 2 connected to the sharp shape in building 4. Then the following pair was connecting the genre of music to architectural style such as classical music (music 4) reminding them of classical buildings (building 1).

[Table 5-12] Keywords from the  
Response of Music Majors

No.	Music-Architecture	Count
1	Mood-Mood	59
2	Sound-Form	37
3	Genre-Style	34
4	Rhythm-Pattern	34
5	Genre-Mood	18
6	Sound-Pattern	11
7	Sound-Mood	9
8	Rhythm-Mood	6
9	Mood-Form	5
10	Sound-Material	4
11	Genre-Form	4
12	Rhythm-Material	3
13	Mood-Pattern	2
14	Rhythm-Form	1
15	Genre-Pattern	1
16	Genre-Material	1
17	Rhythm-Style	1

The music majors have interpreted the mood of music to the mood of architecture the most as well. (Table 5-12) One of the reasons that these two elements were paired is that the music (music 3) was untuneful to listen which also led to the building that was uncomfortable to see in building 5. The second highest pair was the sound of music and the form of architecture by associating the crescendo of the notes in music 1 to the building that is shaped like it is rising with the shape of a cone in building 3. The next pair is the genre of music and the architectural style. The oriental style of music (music 1) was interpreted as the oriental style building in building 5. Then the rhythm of music and the pattern of architecture were connected. Since the rhythm was

regular in music 4, a symmetrical building (building 1) was selected.

[Table 5-13] Keywords from the Response of Other Majors

No.	Music-Architecture	Count
1	Mood-Mood	67
2	Genre-Style	42
3	Rhythm-Pattern	28
4	Sound-Form	22
5	Mood-Form	22
6	Sound-Mood	19
7	Genre-Form	9
8	Rhythm-Form	7
9	Sound-Pattern	6
10	Rhythm-Mood	3
11	Mood-Material	2
12	Genre-Material	2
13	Mood-Style	2
14	Genre-Mood	1
15	Mood-Pattern	1
16	Genre-Pattern	1
17	Sound-Material	1

The other majors have associated the mood of the music and the mood of architecture the most as architecture and music majors have selected. (Table 5-13) The music (music 1) gives a sense of freedom which led to select the building (building 4) that also gave the sense of freedom. Secondly, the genre of music is interpreted as the style of architecture. Since the song is contemporary music (music 5), the building (building 2) that looked like contemporary architecture was chosen. Thirdly, the rhythm from music and architectural pattern were paired by responding that since music 3 has irregular rhythms, it is matched with the building (building 3) that has irregular patterns.

Then the sound of music is connected to the form of architecture. The sound of bells in music 1 reminded the respondents of the shape of a bell in building 3.

[Table 5-14] Overall Keyword Frequency

No.	Music-Architecture	Count
1	Mood-Mood	172
2	Genre-Style	99
3	Rhythm-Pattern	99
4	Sound-Form	96
5	Mood-Form	45
6	Genre-Form	29
7	Rhythm-Form	29
8	Sound-Pattern	26
9	Genre-Mood	23
10	Sound-Mood	18
11	Rhythm-Mood	11
12	Mood-Material	8
13	Sound-Material	8
14	Mood-Pattern	7
15	Genre-Material	5
16	Mood-Style	3
17	Rhythm-Material	3
18	Sound-Style	3
19	Genre-Pattern	2
20	Rhythm-Style	1

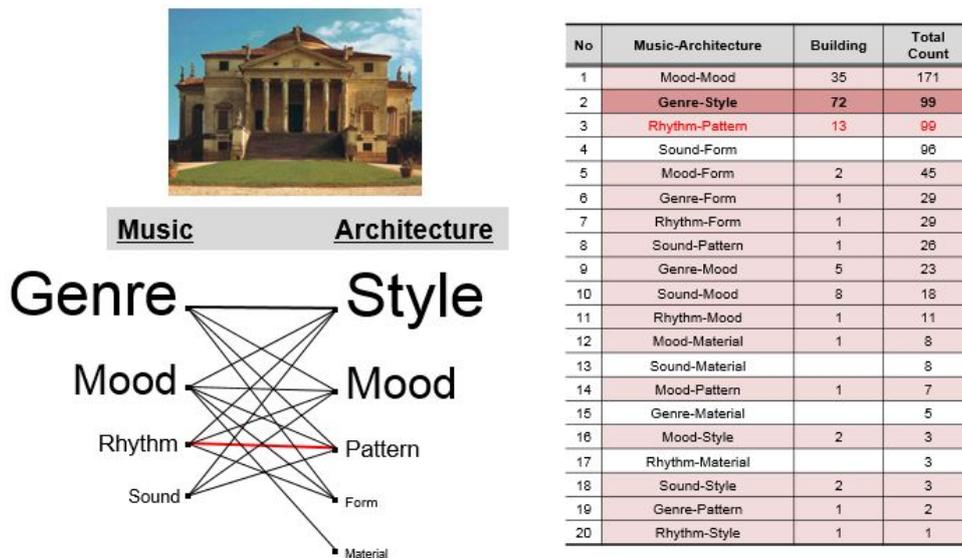
Music	Architecture	Count
Genre	Style	99
	Mood	23
	Form	19
	Material	5
	Pattern	2
Mood	Mood	172
	Form	45
	Material	8
	Pattern	7
Rhythm	Style	3
	Pattern	99
	Form	29
	Mood	11
	Material	3
Sound	Style	1
	Form	96
	Pattern	26
	Mood	13
	Material	8
	Style	3

Although the order was slightly different, until the fourth highest frequencies the pairs of the musical and architectural elements were same, which means that the field of study does not affect the way people perceive musical and architectural factors in musically inspired architecture. The overall keywords are listed in the order of the highest frequency (table 5-14), and people perceived by associating the mood of music to mood of architecture the most. Then the following order is the genre of music to style of architecture, the rhythm from music to the pattern of architecture, and the sound of music to form of

architecture. After organizing the list by the musical element, it appears that each musical element has a representative architectural element. (Table 5-14)

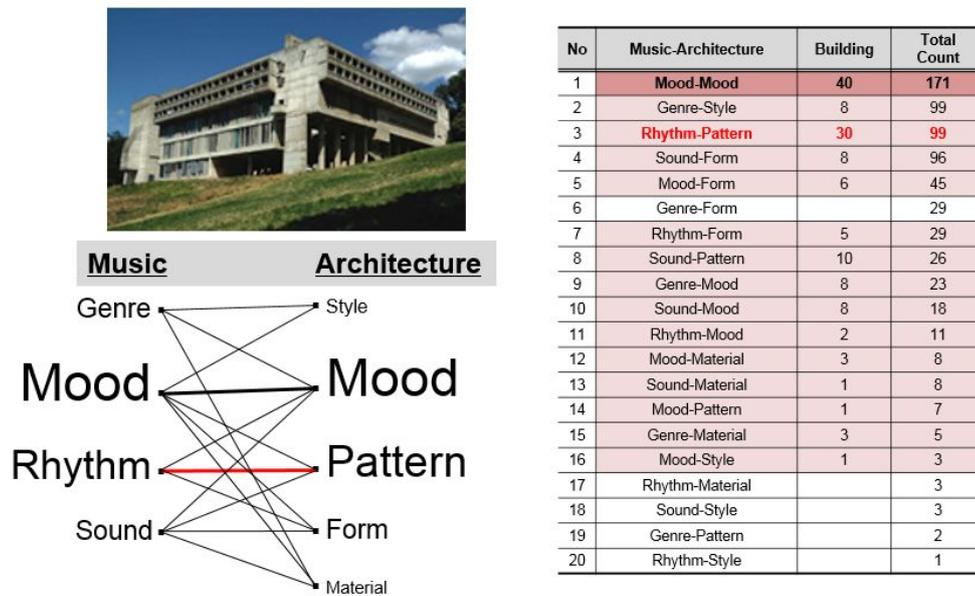
### 5.2.3. Interpretation

The following analysis is on the interpretation of the each building to see more in depth about how the respondents have perceived the musical and architectural elements. The diagram of the keyword frequency is drawn by matching the keywords between music and architecture with different font sizes. As the font size gets bigger, it has a higher frequency. The heaviest line weight refers to the pair of musical element and architectural element that the respondents have selected the most. The red line refers to the architect’s or the composer’s intentions. The table next to the diagram shows the frequency of the keywords in that building and the total count of keywords from all the buildings. The bold font indicates the highest frequency, and the red font refers to the architects’ or the composers’ intentions.



[Figure 5-9] Respondents' Interpretation of Building 1

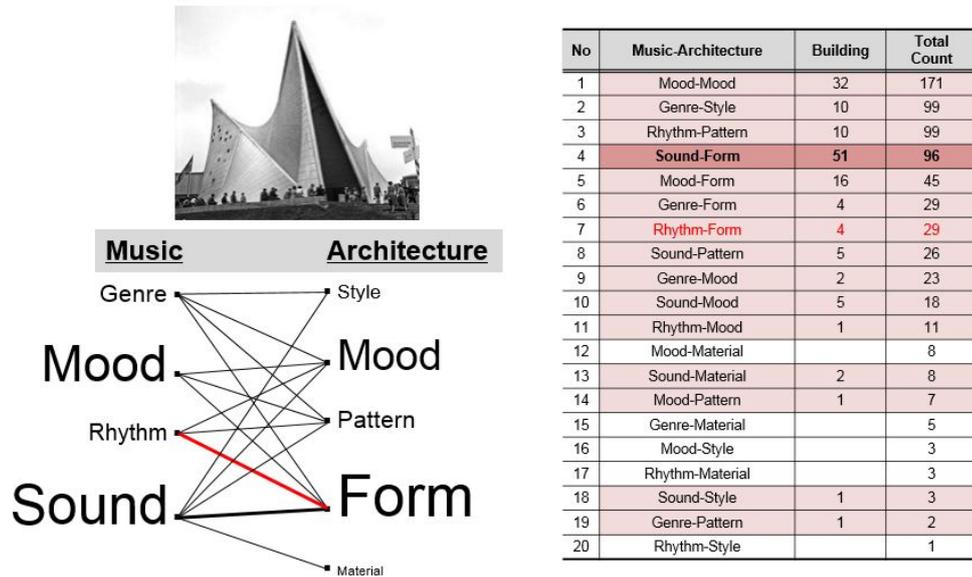
The composer’s intention for building 1 was to express the building’s harmony of proportion and order by the repetitive rhythms, which this translates into musical rhythm and architectural pattern. However, a large number of respondents have responded that musical genre is interpreted as the architectural style because classical music reminds them of classical style building. This reveals that the respondents have connected the music that represents the period to the architectural style that represents the period. (Figure 5-9)



[Figure 5-10] Respondents' Interpretation of Building 2

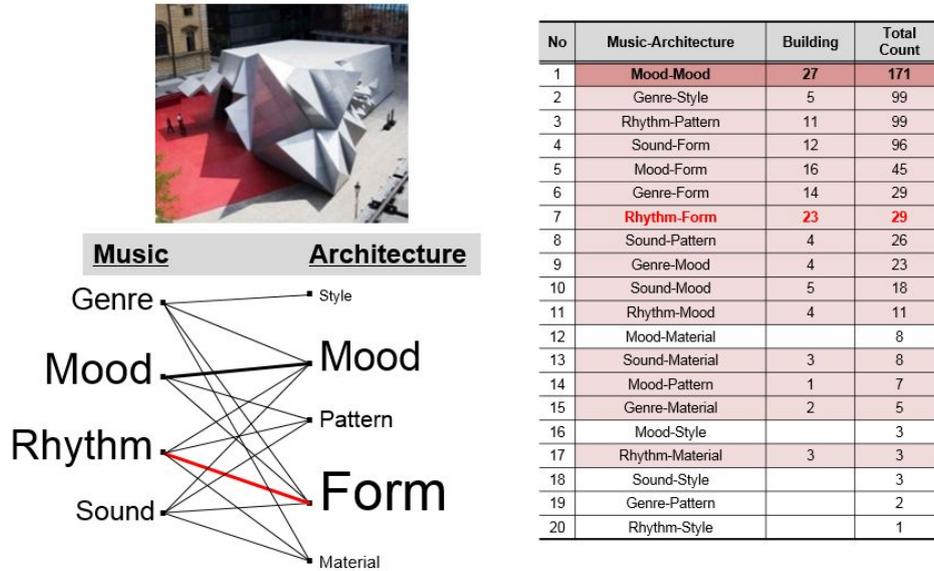
The architect of building 2 has used the vertical strip for the proportions of the windows to represent the glissando and the rhythm from the song, which translates into musical rhythm and architectural pattern. Despite the architect’s intention, the respondents have perceived the mood of the song to the mood of the building. The respondents have stated that the frightening song goes with the frightening looking building, and the music that gives cold feelings goes with the building that looks like a hospital. This shows that the respondents

have looked at the whole mood of the song and the building instead of observing the small detailed elements. (Figure 5-10)



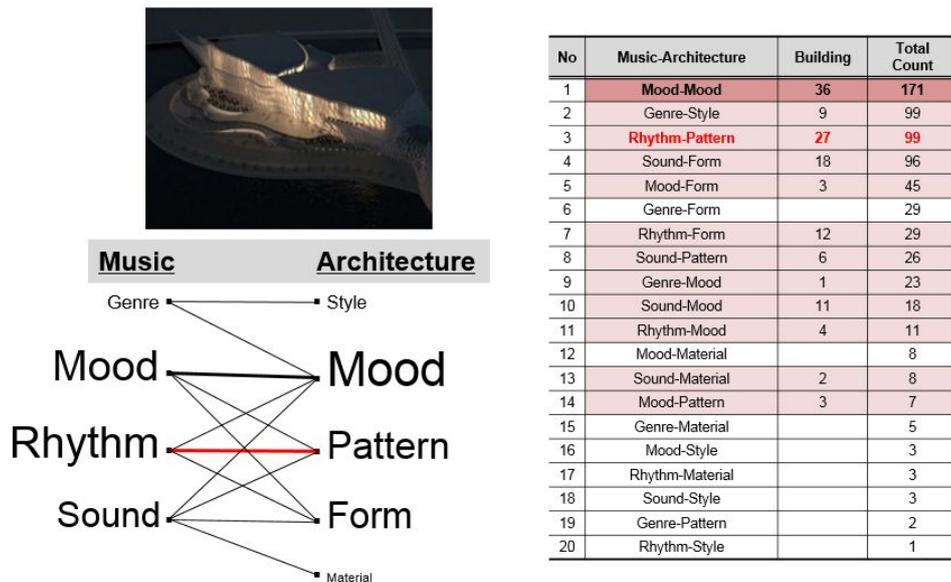
[Figure 5-11] Respondents' Interpretation of Building 3

The architect of building 3 has expressed the glissando and rhythm by lines and curves, which became a complex and connected form called hyperbolic paraboloid. Even though the architect's intention was to connect the musical rhythm to architectural form, the respondents have responded that the sound of music connects to the architectural form. Most of the respondents have felt that the sharp sound of the song reminded them of the shape that is sharp, and the sound that sounds like bells reminded them of the shape of a bell. This presents that people have associated the general mood of the song to general mood of the building, and the instrument that was used in the music with the form of the instrument. (Figure 5-11)



[Figure 5-12] Respondents' Interpretation of Building 4

In building 4, the architect has planned to depict the rhythm from the music with the form of the building by analyzing the frequency of the song and making a three dimensional model. There was only a slight difference between the architect's intention and the result stating that the strong beats connects with the pointy shaped skin of the building. However, the result shows that the respondents have associated the mood of song and the mood of the building the most. The respondents have felt the freedom from the song, so they have selected the building that gave the feeling of freedom. This is another case of the respondents perceiving the overall mood of the song and building. (Figure 5-12)



[Figure 5-13] Respondents' Interpretation of Building 5

The architect of building 5 has aimed to express the complex rhythms by utilizing the pattern of the building with strip morphology, which translates that the pattern of the building is formed from the rhythm in music. From the responses, even though some respondents have associated the rhythm with the pattern from the building, many respondents have connected the mood of the music and the mood of the building as well. They felt that the music gave the feeling of tension, which led them to match with the building that gave the feeling of tension as well. The respondents have focused more on the overall feeling than the individual elements. (Figure 5-13)

This analysis presents that each of the respondent's emotions have influenced the results. However, despite the fact that all the respondents have received different emotions from the buildings, they were all looking at the similar musical and architectural elements. Moreover, although the respondents were not able to accurately grasp the architects and composers' purposes, they were all able to perceive the musical factors from architecture. As long as the intentions

were not too complicated or the musical genre and architectural style were not too definite, the respondents were able to identify the intentions to a certain extent.



## **Chapter 6 Conclusion**

The significance of this research is to identify the architectural expression in music, that is, the perception of musically inspired architecture through the survey questionnaire. This is the first empirical study that examines the perceptions of the visitors when visiting the musically inspired architecture. The results of the survey reveals that the average time of listening to music per day, number of experience in music, duration of experience in music, interested music genre and the number of correct answers by different majors had no correlations with the result of this research. This also shows that the respondents making the correct and incorrect matches did not affect the result of this study. The examination of the respondents' response on the reasons why they have corresponded such music and the building was more important and helpful in identifying people's perceptions on musically inspired architecture. Then, the comparison between the expected values and the research result present that people in fact were sensing the musical experience through architecture. People identified and matched with the similar musical and architectural elements such as genre, mood, rhythm and sound in music, and style, mood, pattern, form and material in architecture. As a result, people have perceived the overall mood and environment of the music and architecture rather than looking at the specific elements the most. The analysis on the respondents' interpretations on each of the five buildings have shown that each of the respondent's emotions have affected the result of this study, which resulted in people perceiving differently from the architects and composers' intentions.

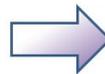
The result of this research reveals that the relationship between music and architecture is different from the relationship between music and architecture that was mentioned in the theoretical study in chapter 2. (Figure 6-1) While the existing relationship was composed with more specific technical elements, the elements of the relationship from the research result were broader and comprehensive. Furthermore, the elements of the relationship were more diverse and more detailed by each of the elements branching into different elements.

Relationship between Music and Architecture (Theory)

Music	Architecture
Rhythm	Point
Melody	Line
Harmony	Surface
Timber	Material
Tone Color	Color

Relationship between Music and Architecture (Research result)

Music	Architecture
Genre	Style
	Mood
	Form
	Material
	Pattern
Mood	Mood
	Form
	Material
	Pattern
	Style
Rhythm	Pattern
	Form
	Mood
	Material
	Style
Sound	Form
	Pattern
	Mood
	Material
	Style



[Figure 6-1] Comparison of the Relationship between Music and Architecture in the Past and the Research Result

Design approach from musical elements

Music	Architecture	Count
Genre	Style	99
	Mood	23
	Form	19
	Material	5
	Pattern	2
Mood	Mood	172
	Form	45
	Material	8
	Pattern	7
Rhythm	Style	3
	Pattern	99
	Form	29
	Mood	11
Sound	Material	3
	Style	2
	Form	96
	Pattern	26
Sound	Mood	18
	Material	8
	Style	3

Design approach from architectural factors

Architecture	Music	Count
Style	Genre	99
	Mood	3
	Sound	2
	Rhythm	2
Mood	Mood	172
	Genre	23
	Sound	18
	Rhythm	11
Pattern	Rhythm	99
	Sound	26
	Mood	7
Form	Genre	2
	Sound	96
	Mood	45
Material	Rhythm	29
	Genre	19
	Sound	8
	Material	8
Rhythm	Genre	5
	Mood	8
Rhythm	Rhythm	3

[Figure 6-2] Design Approaches

Through the analysis of the respondents' short-answer responses, many of the

respondents have interpreted from music to architecture, but they also have interpreted reversely from architecture to music. Therefore, when the architects are planning to design buildings by using musical elements, they should choose one from the two of the design approaches: design approach from musical elements and design approach from architectural elements. (Figure 6-2)

This research is the first empirical study that examines the perceptions of those who experience the space of musically inspired architecture. This is measured through the survey questionnaires with basic information about the respondents' experience in music, and matching the music with corresponding buildings in their opinions. Instead of exploring the architectural design method only within the field of architecture, the ideas should also be sought from another form of art in order to produce more creative, systematic and logical designs. Thus, the results of this study will help suggesting the ideas of design for architects who are seeking to express the musical qualities through architecture. Moreover, through further studies, more effective directions in architectural planning are to be provided for the architects with other forms of art as well.



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# Appendix

- 
- **Survey Questionnaire**
  - **Architecture Major Answer (Example)**
  - **Music Major Answer (Example)**
  - **Other Major Answer (Example)**
-

## Music-Architecture Survey Questionnaire

### 1. General Information

1.1 Gender    ① Male    ② Female

1.2 Age    \_\_\_\_\_

1.3 Major    ① Architecture    ② Music  
              ③ Other (\_\_\_\_\_)

1.4 Final Education (For students select the current status)

① Bachelor's    ② Master's    ③ Ph.D    ④ Other

1.5 On average, how much do you listen to music on a daily basis?

- ① I don't listen to music    ② Less than 1 hr  
③ 1~2 hrs    ④ 2~5 hrs    ⑤ 5~8 hrs  
⑥ More than 8 hrs

1.6 What kind of music are you interested in?  
(Select all that apply)

- ① Rock/Metal    ② Pop    ③ Classical    ④ Jazz  
⑤ Indie    ⑥ Hiphop/R&B    ⑦ Country  
⑧ Electronic    ⑨ Ballad    ⑩ Dance    ⑪ Trot  
⑫ Others (\_\_\_\_\_)

1.7 Are you currently involved in any activities that are related to music or have any music experiences in the past? If so, what is it and for how long? (ex: piano, 5 years)

\_\_\_\_\_    \_\_\_\_\_ Years  
\_\_\_\_\_    \_\_\_\_\_ Years  
\_\_\_\_\_    \_\_\_\_\_ Years

### 2. Experiment

※ After listening to each song (2min 30sec each), select a building that might be related to the music in your opinion, and explain why you selected such building. You may listen to the music more than once if needed. (The building may NOT be selected more than once)

Music	Building	Reason
1		
2		
3		
4		
5		

### 3. Post-Experiment

※ Are you familiar with any of the buildings or music? Select all that apply.

- ① Building1    ② Building2    ③ Building3    ④ Building4    ⑤ Building5    ⑥ Music1    ⑦ Music2    ⑧ Music3  
⑨ Music4    ⑩ Music5    ⑪ None of the above

## Music-Architecture Survey Questionnaire

### 1. General Information

1.1 Gender  ① Male  ② Female

1.2 Age 26

1.3 Major  ① Architecture  ② Music  
 ③ Other (\_\_\_\_\_)

1.4 Final Education (For students select the current status)

① Bachelor's  ② Master's  ③ Ph.D  ④ Other

1.5 On average, how much do you listen to music on a daily basis?

- ① I don't listen to music  ② Less than 1 hr  
 ③ 1~2 hrs  ④ 2~5 hrs  ⑤ 5~8 hrs  
 ⑥ More than 8 hrs

1.6 What kind of music are you interested in?

(Select all that apply)

- ① Rock/Metal  ② Pop  ③ Classical  ④ Jazz  
 ⑤ Indie  ⑥ Hiphop/R&B  ⑦ Country  
 ⑧ Electronic  ⑨ Ballad  ⑩ Dance  ⑪ Trot  
 ⑫ Others (\_\_\_\_\_)

1.7 Are you currently involved in any activities that are related to music or have any music experiences in the past? If so, what is it and for how long? (ex: piano, 5 years)

None \_\_\_\_\_ Years  
 \_\_\_\_\_ Years  
 \_\_\_\_\_ Years

### 2. Experiment

※ After listening to each song (2min 30sec each), select a building that might be related to the music in your opinion, and explain why you selected such building. You may listen to the music more than once if needed. (The building may NOT be selected more than once)

Music	Building	Reason
1	3	There are random spikes of sound in the music and this building portrays precise spikes.
2	2	The music was rock genre and the building reminded me of a harmonica through its facade.
3	4	Piano had constant random spikes in sound and this building perfectly portrays randomness.
4	1	This sound is classical and the facade of the building just represents a traditional, classic architecture.
5	5	The music reminded me of sound waves and the facade of the building sort of looks like soundwaves moving rapidly.

### 3. Post-Experiment

※ Are you familiar with any of the buildings or music? Select all that apply.

- ① Building1  ② Building2  ③ Building3  ④ Building4  ⑤ Building5  ⑥ Music1  ⑦ Music2  ⑧ Music3  
 ⑨ Music4  ⑩ Music5  ⑪ None of the above

## Music-Architecture Survey Questionnaire

### 1. General Information

1.1 Gender  ① Male  ② Female

1.2 Age 29

1.3 Major  ① Architecture  ② Music  
 ③ Other (\_\_\_\_\_)

1.4 Final Education (For students select the current status)

① Bachelor's  ② Master's  ③ Ph.D  ④ Other

1.5 On average, how much do you listen to music on a daily basis?

① I don't listen to music  ② Less than 1 hr  
 ③ 1~2 hrs  ④ 2~5 hrs  ⑤ 5~8 hrs  
 ⑥ More than 8 hrs

1.6 What kind of music are you interested in?  
 (Select all that apply)

① Rock/Metal  ② Pop  ③ Classical  ④ Jazz  
 ⑤ Indie  ⑥ Hiphop/R&B  ⑦ Country  
 ⑧ Electronic  ⑨ Ballad  ⑩ Dance  ⑪ Trot  
 ⑫ Others (\_\_\_\_\_)

1.7 Are you currently involved in any activities that are related to music or have any music experiences in the past? If so, what is it and for how long? (ex: piano, 5 years)

Viola 12 Years  
Singing 16 Years  
 \_\_\_\_\_ Years

### 2. Experiment

※ After listening to each song (2min 30sec each), select a building that might be related to the music in your opinion, and explain why you selected such building. You may listen to the music more than once if needed. (The building may NOT be selected more than once)

Music	Building	Reason
1	2	I associate the era of the music with the era of the building. (60s-70s)
2	4	The rock music has a sharp edge to it like the building.
3	3	The music sounds modern. The building is almost shaped like a piano.
4	1	The music has a classical feel to it like the building.
5	5	The music sounds dark and ominous, and the building is obscured in darkness.

### 3. Post-Experiment

※ Are you familiar with any of the buildings or music? Select all that apply.

① Building1  ② Building2  ③ Building3  ④ Building4  ⑤ Building5  ⑥ Music1  ⑦ Music2  ⑧ Music3  
 ⑨ Music4  ⑩ Music5  ⑪ None of the above

## Music-Architecture Survey Questionnaire

### 1. General Information

1.1 Gender    ① Male    ② Female

1.2 Age    25

1.3 Major    ① Architecture    ② Music  
               ③ Other (human development)

1.4 Final Education (For students select the current status)

① Bachelor's    ② Master's    ③ Ph.D    ④ Other

1.5 On average, how much do you listen to music on a daily basis?

- ① I don't listen to music    ② Less than 1 hr  
 ③ 1~2 hrs    ④ 2~5 hrs    ⑤ 5~8 hrs  
 ⑥ More than 8 hrs

1.6 What kind of music are you interested in?

(Select all that apply)

- ① Rock/Metal    ② Pop    ③ Classical    ④ Jazz  
 ⑤ Indie    ⑥ Hiphop/R&B    ⑦ Country  
 ⑧ Electronic    ⑨ Ballad    ⑩ Dance    ⑪ Trot  
 ⑫ Others (\_\_\_\_\_)

1.7 Are you currently involved in any activities that are related to music or have any music experiences in the past? If so, what is it and for how long? (ex: piano, 5 years)

symphonic orchestra    4 \_\_\_\_\_ Years  
 piano (private)    12 \_\_\_\_\_ Years  
 \_\_\_\_\_    \_\_\_\_\_ Years

### 2. Experiment

※ After listening to each song (2min 30sec each), select a building that might be related to the music in your opinion, and explain why you selected such building. You may listen to the music more than once if needed. (The building may NOT be selected more than once)

Music	Building	Reason
1	3	building looks like it would be a great place to test out the 'acoustics' of this music. for example, listening to this piece and how it sounds based on where you are sitting in this building
2	4	the building "feels" the way the song does. the strong and upbeat tempo seems on par with the strong "statement" that the building is making
3	5	the piece sounds "complicated" and jarring -- harmonious but disruptive at the same time. the harmony speaks to the flow of the building. maybe the disruption speaks to the 'innovation' of the building and its architecture?? the building also reminds me of a piano
4	1	music is dark but rhythmic. the music tells a story. seems like a great place to play conventional orchestra music? very orderly (this building is roman right?)
5	2	this is a VERY unpleasant sounding music (to my ears), and it can only go with the most unpleasant looking building out of the five.

### 3. Post-Experiment

※ Are you familiar with any of the buildings or music? Select all that apply.

- ① Building1    ② Building2    ③ Building3    ④ Building4    ⑤ Building5    ⑥ Music1    ⑦ Music2    ⑧ Music3  
 ⑨ Music4    ⑩ Music5    ⑪ None of the above

## 음악의 건축적 표현: 음악적 요소를 반영한 건축에 대한 인식

지도교수 최재필  
서울대학교 대학원 건축학과 유세원

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현대 문화는 청각적 요소보다 시각적 요소에 더 많은 영향을 받고 있기 때문에 우리는 시각적 자극에 더 익숙한 삶을 살고 있다. 보통 어떠한 것을 인지할 때, 우리는 대상의 시각적인 정보를 받아들이는 것이 일반적이다. 그런데 만약에 대상의 정보가 청각적인 요소로 다가온다면 우리는 시각에 익숙한 만큼 청각적 요소를 시각적인 요소로 어떻게 가시화시킬지도 생각할 수 있을 것이다. 많은 사상가와 건축가들도 역사적으로 시각과 청각에 유사한 연관성이 있다고 언급해 왔듯이, 같은 맥락에서 음악과 건축의 상관관계 또한 매우 밀접하다고 판단된다.

음악은 청각에 의존하고 건축은 시각에 의존하는 예술이기 때문에 음악을 건축에 접목하면 보이지 않는 것을 보이는 것으로 실체화시킬 수 있다. 또한 음악의 여러 가지 특성을 건축에 활용하면 창의적이고 체계적인 디자인 방법이 될 수 있고 방문자들이 즐길 수 있는 명소가 될 수 있으며, 특정 시대의 문화나 사회적 특성 역시 나타낼 수 있다.

본 연구는 음악적 요소를 반영한 건축물들을 관찰하여 이러한 경험을 가능하게 한 건축적인 요소들과 음악적인 요소들이 무엇인지 살펴보고 두 분야 간의 관계성을 분석하는 데에 목적을 둔다. 연구는 다음과 같은 과정으

로 이뤄진다. 첫 째로 음악과 건축의 역사 고찰을 하고 음악과 건축의 관계성을 조사하고, 이때 나타는 음악으로부터 영감을 받은 건축의 사례들을 음악 요소에 따라 분석을 한다. 연구의 방법으로는 직접 건축, 음악 그리고 그 외의 전공자들에게 음악을 들려주고 건물을 맞추게 하는 설문조사를 통해 사람들이 어떻게 건축에 적용된 음악을 인식하는지 알아보고자 했다. 이와 같은 설문조사의 결과를 바탕으로 음악요소를 적용한 건축적 경험이 어떻게 가능한지 키워드를 도출하여 통계적으로 분석했다.

본 논문은 이처럼 음악적 요소를 건축에 적용할 수 있는 가능성을 밝히고 어떤 음악적 요소들과 건축적 요소들이 상관관계가 있는지 알아보고자 하는 것을 목적으로 한다. 이에 따른 연구결과는 음악의 특성을 건축으로 표현하는 방안을 모색하는 건축가들에게 전보다는 더 창의적이고 효과적인 계획방향을 제시해 줄 수 있을 것으로 기대된다.

**주요어 : 음악과 건축, 인식, 건축적 표현**

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