

Berklee College of Music

The Architecture of Musical Expression

Submitted in Partial Fulfillment of the Degree of
Master of Music in Music Production, Technology, and Innovation

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Abstract

This project aims to explore the inherent relationship that exists between music and architecture. From the design of concert halls to how architecture can shape itself to sound as a means of reflecting space, this cross-disciplinary approach aims to investigate beyond the interweaving similarities between the two in terms of proportion and underlying rhythms. Apart from the circumscribed aesthetics and acoustics, this project will delve into music and architecture as an immersive experience by interconnecting directly the design of a space with a composition of music and research the experiential quality of inhabiting a space. Through audiovisual elements and 3D modelling tools, each piece of music presented here will have an ‘architectural space’ that has been created specifically from the same elements presented in the music, to not only showcase the final product of making the ‘architecture of music’ but also the process by which it can a spatial experience can be achieved.

Keywords: Architecture, Music, 3D modelling, design, audiovisual.

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1. Introduction

This is an exploration of the abstract connection that lies between architecture and music. A musical composition takes you through an experience that sparks a sensory reaction through time whilst architecture aims to heighten your senses through the manipulation of light and space. Yet as different as these two disciplines may be at first glance, there is a sense of ephemerality that happens during the appreciation of music, that in the attempt for permanence in architecture, the experience can still be as ephemeral and valued while traversing through space. Both are using ways to immerse yourself in a narrative or emotion using similar expressions. It is this search for stimuli of the senses that inspired the search for a deeper understanding of both and how each convey the emotion they transmit. Both offer an immersive experience, embracing your senses through the same principles, and this project aims to delve further and not only seek to reaffirm such relationships but also on how both disciplines are interpolated in the process of design and composition between each other. It is through an understanding of the composition of music in tandem with the design of architecture that we are able to appreciate each other and see how one can also affect the other visually, aurally and spatially.

2. Review of the State of The Art

The relationship between music and architecture has been a field that has been investigated by members of both disciplines in various moments in history. To start with some of the most interesting connections between both, first it is important to acknowledge the parallel attributes they share in composition. Both are based in principles on rhythm, harmony, and proportion that can be seen in countless instances, from the geometrical proportions found in Ancient Greek colonnades to the harmonic sequence Pythagoras studied.¹ And beyond their similarities in form, content and expression, these disciplines also share an overlap in cultural parentage that is still evident to this day. As Leon Botstein eloquently explains in an article from the *The Musical Quarterly*, as music became more available, and the audience for public art grew, so did the need for architecture and urban development in the nineteenth century.² Suddenly the concert halls, and opera houses being developed were also habited by those in the private spaces being developed as cities grew. It shouldn't be a surprise then why there is an overlap in styles when we talk in architectural history as well as in music, as how it happens in art, they are also a stark reflection of what is happening our society.

The notion of linking these with the relationships discussed were further explored and interpreted with different ideologies in philosophy during the nineteenth century but continued well on into the twentieth century. Such is the notable case of Iannis Xenakis, musicologist and architect who

¹ Richard L. Crocker "Pythagorean Mathematics and Music." *The Journal of Aesthetics and Art Criticism* 22, no. 3 (1964): 325-35. Accessed November 10, 2020. doi:10.2307/427236.

² Botstein, Leon. "Notes from the Editor: Sanctioned Daydreams: Music, Pictures, and Architecture." *The Musical Quarterly* 94, no. 3 (2011): 271-77. Accessed November 10, 2020. <http://www.jstor.org/stable/41289208>.

worked under one of the well-known pioneers of modern architecture, Le Corbusier in the 1950s. His work under Le Corbusier is a clear example in applying these relationships as mentioned by M. J. Grant in the Oxford Journal of *Music and Letters*.³ Xenakis investigated and applied his musical concepts into the physical world, such as ‘masses of string glissandi’ which was the defining idea behind the Philips Pavilion. This study didn’t stop with him and we can appreciate more recent examples where music has served as an inspiration for architecture as is the case with Daniel Libeskind and his design process for the Jewish Museum in Berlin, where his fascination for Schoenberg contributed to his abstraction of ‘inaudible music’ while composing the lineaments of the museum⁴. An even more recent example is architect Steven Holl, showcasing in *Architectonics of Music* some projects where he has taken pieces from composers and take their geometric potential into physical buildings. Taking inspiration from music and see how it can relate making analogies that make sense with a schematic design program.⁵

This project aims to continue such fascinating connection and studies with a different interpretation. The project will be focused on the process of simultaneously design and compose architecture and music and showcasing it through digital media. By creating different three-dimensional environments with corresponding pieces of music, the project will not only show an ‘architecture’ that corresponds rhythmically, harmonically and proportionately with a musical

³ Grant, M. J. Review of Music and Architecture. *Music and Letters* 91, no. 3 (2010): 465-467. muse.jhu.edu/article/394878.

⁴ Young, James E. "Daniel Libeskind's Jewish Museum in Berlin: The Uncanny Arts of Memorial Architecture." *Jewish Social Studies*, New Series, 6, no. 2 (2000): 1-23. Accessed November 10, 2020. <http://www.jstor.org/stable/4467574>.

⁵ Holl, Steven. 2017. “The Architectonics of Music.” *PAJ: A Journal of Performance & Art* 39 (2): 50–64. doi:10.1162/PAJJ_a_00363.

composition but will also correspond in its content and its form. Digital 3D modelling tools such as Revit, Blender, Unity, SketchUp allow for architecture design to exist in the computer and mobile environment and are great tools for the development of this project. In addition, Visual programming languages such as Max/MSP and TouchDesigner also allows for audio/video/3D manipulation that present opportunities in the creation of both. This will also entail to create a collection of musical compositions in tandem, and that correlate with the visual representation of each. Through a collection of electronic musical compositions that highlight different parameters, a relationship can be made in the design process of each 'architectural space' assigning musical elements to architectural features that can be interpreted when experiencing both at the same time. Such parameters include and are not limited to exploring the visualization of wavetable synthesis in 3D space, the assignment of rhythmic values in architectural space among others. The product of such process will result in a collection of spaces that are designed for and with music that can be interacted with through video images.

3. Description

A few years back, the beginning of this investigation started with the conception of a song written by singer/songwriter and designer Jesús Pineda. The song described how the moon is in love with the sun and how 'she' spends every night chasing 'him', explaining the cycle of night and day while giving them personality. The relationship for that unrequited love was the primary inspiration for an architecture studio project designed by Jesús which consisted in a mixed-use building in Istanbul, Turkey. It used the main story as a design drive which aimed that even though the moon would never reach the sun, at least she could connect through the building's design, at different times both elements would be connected through an oculus and reflective pool which shaped the orientation for each section of the building program.

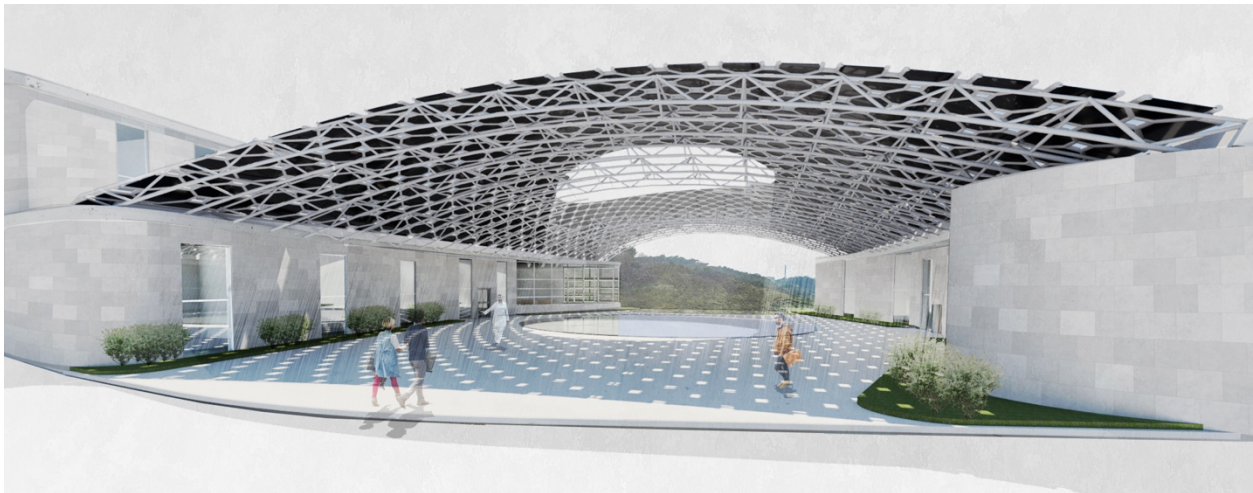


Figure 1 'Alqamar' designed by Jesús Pineda

While it still had to follow a building program and be functional, for the designer, the most important and most striking part of every design is in its emotion to connect. Music serves the same

purpose for Pineda, the same way something as abstract as music can bring so much emotion and connection, so does an architectural space can bring an equal and powerful response.

As discussed, the relationship between these two has been investigated by members of both disciplines throughout history, all of them approaching the relationship from different angles, using music as a means to define form and making analogies that make sense with schematic building design. This project aimed to explore another way such relationship could exist. The focus started on the process of designing and composing architectural spaces and music respectively using 3D modelling tools. Considering that tools such as Building Information Modelling Software (BIM)⁶ are taking an important role in modern architecture studios, the main direction this project went into was in finding a tool that fit exploration in creating a virtual environment. Autodesk Revit and AutoCAD serve as prime examples for BIM software, as they are used in most commercial studios.⁷ However, as they are used for commercial applications, programs like these can run for a price of up to \$2,545 per year.⁸ Granted, they do have a free education model that allows student to use their programs at no cost for a limited time. Yet, another obstacle stood in the way when considering using these familiar tools. Revit, which is the main 3D BIM software, is a Windows-based program and cannot be used on a MacBook Pro (which is the main workstation for this investigation), unless it is installed in a compartmentalized hard drive using Boot Camp, which allows you to install Windows on an Apple

⁶ Nick Marchek et al., "The Future of BIM Software - What to Expect," Geospatial World, May 7, 2021, <https://www.geospatialworld.net/blogs/the-future-of-bim-software-what-to-expect/>.

⁷ Martin, Rory. "Sustainability and Building Information Modelling (BIM)." Environment Design Guide, 2017, 1-18. Accessed June 13, 2021. <https://www.jstor.org/stable/26379916>.

⁸ "Revit Software: Get Prices & Buy Official Revit 2022," Autodesk, June 9, 2021, <https://www.autodesk.com/products/revit/overview?term=1-YEAR>.

computer.⁹ Given past experience, not only does it take a significant amount of space but in previous endeavors, complications have happened when using Revit on a MacBook Pro. Other BIM programs such as SketchUp, which at the end of 2020 moved to a subscription model¹⁰, were not as appealing when compared to the alternative that was chosen for the initial instances of this project. Blender¹¹ is a free and open-source 3D computer graphics software used for creating animations, visual effects, art and so much more. It quickly became very promising as it also allows users to delve into simulations, sculpting and even audio reactive applications that will be discussed further along as it was this last instance that would change the direction of the project as well as the use of additional tools to create the spaces described with their respective musical composition. In its totality, this project is condensed in a collection of musical compositions presented in their own environment, created for and by them, daring to challenge the composition of space and the definition of what architecture can be.

⁹ “Apple® Boot Camp Support for Autodesk® Revit® Products,” Apple® Boot Camp Support for Autodesk® Revit® Products | Revit Products | accessed June 13.

¹⁰ “Plans and Pricing.” SketchUp. Accessed June 13, 2021. <https://www.sketchup.com/plans-and-pricing#for-personal>.

¹¹ Blender Foundation, “About Blender,” blender.org, accessed June 13, 2021, <https://www.blender.org/about/>.

4. Innovative Aspects

Another goal in this project was set in translating music into actual 3D forms. Music would for sure be an inspiration, but to differentiate this study to the ones done in the past, the decision was that whatever 3D space made it would also be created by the musical composition. One instance involved using Blender, importing images showing MIDI from the project and using that to start articulating forms and further develop a space.

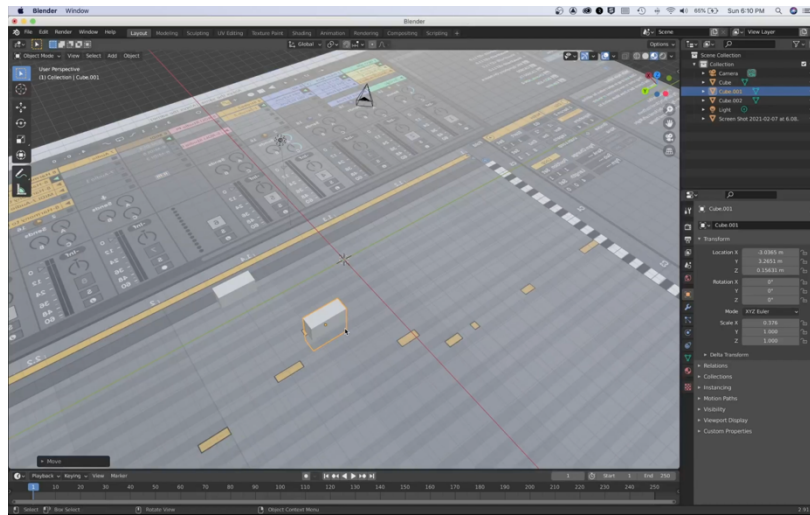


Figure 2 Example of articulating MIDI into 3D forms, taken by Jesús Pineda

But after investigating different kinds of synthesis for the composition aspect of the project and after working with different synthesizers, an observation arose from working with wavetable synthesizers in particular. Wavetables more often than not seem like a 3D loft or mesh, and that's because they are a sequence of waveforms morphing through time.¹² In theory, one could create 3D meshes or elements that could then be segmented into waveforms and placed into a wavetable software-synthesizer. In addition, further questions arose: What would a square wave look like if it was extruded? Wouldn't it look like a set of walls?

¹² Boulanger, Richard; Lazzarini, Victor, eds. (2010-10-22). "3.2.3 Table-Lookup Oscillators". *The Audio Programming Book*. Foreword by Max Mathews. MIT Press. p. 335–336. ISBN 978-0-262-28860-6.

After studying the manual for the popular virtual instrument Serum by Xfer Records, it was enlightening to find out that you can import a PNG (image) into a wavetable, and it will interpret the pixel size and stretch it so that it can have 256 frames for each of the waveforms.¹³ This means that anyone can render out luminance maps for a complex shape in a 3D environment and use it in an oscillator in Serum. This theory was later tested by creating an original material using Perlin noise¹⁴, which is a gradient noise used in visual effects to increase realism in cg graphics. displacing information across the z-axis, punching in the parameters to make a high contrast image, rendering it out as a PNG and then back to Serum, using the image as an oscillator creating a 3D modelled wavetable. Given that the displacement parameters used resemble a complex wavetable of sine waves, the result combined with the different effects within Serum and changing its wavetable position actually created a pleasant sound, therefore using sound design in an innovative way.

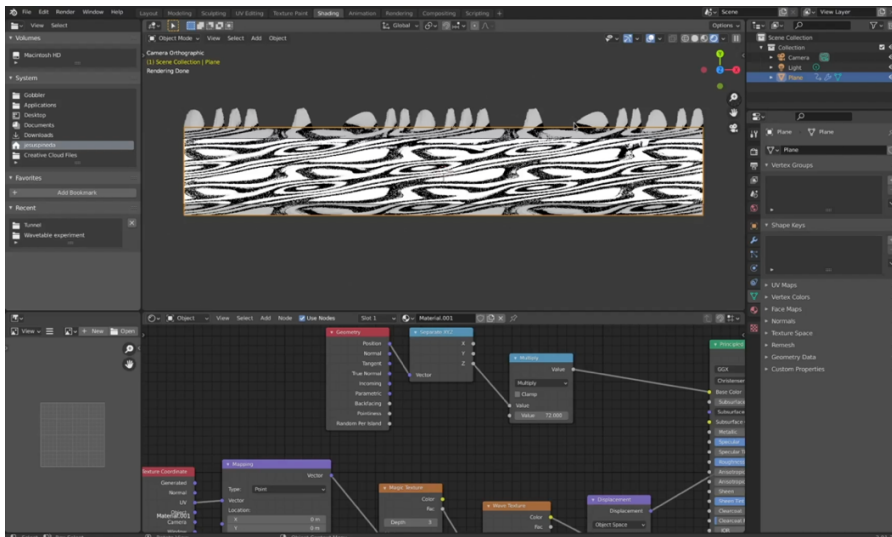


Figure 3 Material Node Window in Blender, creating a wavetable. Taken by Jesús Pineda.

¹³ Duda, Steve. “Serum.” Computer software. *Serum Advanced Wavetable Synthesizer*. Steve Duda, March 5, 2019. <https://xferrecords.com/products/serum>.

¹⁴ Möller Tomas, Eric Haines, and Naty Hoffman. *Real-Time Rendering*. Boca Raton: CRC Press, 2019.

This presented a promising start with the initial goals. It allowed for synthesizer sounds, which would be used for the composition of the music, be translated into 3D and in turn, it paved way into a correlative process of designing, modelling and writing simultaneously.

However, while the importance of the relationship with these two disciplines remained in creating both in tandem, the interest in creating environments from music literally through 3D software presented itself as an innovative new method for instancing space in architecture and provided a different point of view in the generation of form, parting from music, to generate art and unique visualizations. It opened different avenues that involved an abstract understanding of space through experiential and ephemeral art that will be discussed moreover. The further exploration of audio reactive visuals as well as challenges involving the development of individual 3D models would determine the course of this investigation.

4. New Skills Acquired

It is without a doubt, that the learning of new software and techniques can be a fulfilling and very insightful experience. For this study, the understanding of 3D modelling software such as Blender was critical as discussed before, nonetheless music production was not one to be left aside as it was also essential for the purpose of this project. This required to be very comfortable with modern digital audio workstations (DAW) such as Ableton Live and Pro Tools for the manipulation and mixing of songs, which also served as the main composition tool for the tracks in this project. Sound design would also play an important role when assigning parameters and in delivering an immersive experience through audio. Common topics enclosed in within sound designed include a deep understanding of different kinds of synthesis and mixing.

In addition to these it was also very important to touch base in design concepts especially in regards of composition and arranging, general interpretation of the use of color also came in beneficial when creating the different spaces. This subsequently led to learning more about node and material creation in Blender and diving deeper in audio reactive programs such as Max and Touch Designer, programs that are primarily interacted with node-visual way of coding and asked for the investigation to research in Python and visual learning. Definitely, these fields will be important for the continuation of this project in the future but learning concepts can also be applied to different areas in the music, architecture and art environments. This study has served as a means of not only, considering new ways for creating but also to learn fascinating skills for future use and exploration.

5. Challenges: both expected & unanticipated

A series of environments were created using this principle initiated by the creation of wavetables, combined with taking separate elements from the music and creating a 3D model for each of them and then placing them and creating the ‘architecture of the track’. With these experimental environments, a variety of obstacles and insights were discovered and were crucial for the development of the main project. By taking cues from the beat of each of the tracks and looking into the texture of the moving pads and elements with a song, the decision on creating moving environments was definitely one that pushed forward the imagination of what the architecture in this project really is. As songs have a beginning and end, taking the listener in a journey, it was only coherent for this project to also include spaces that present themselves in a linear fashion or that create a sense of space. Such realizations opened the door to the world of visuals used in modern-day musical presentations. Artists such as Mike Winkelmann, famously known as BEEPLE, have created VJ loops which are released under the Creative Commons license and have been used by countless artists for commercial and non-commercial work.¹⁵ This presented an opportunity for the architecture of this project to be ever-morphing, changing along with the music. It posed the opportunity to also have yet another skill that could be then used for other applications with music.

In addition, it questioned an even deeper inquiry in the fact that architecture (especially in this study) does not necessarily mean to design a building but rather a space. A fascinating concept that has been brought up by scholars in the past, questioning the intersection of architecture within art and

¹⁵ “VJ LOOPS: BEEPLE: the Work of Mike Winkelmann,” beeples, accessed June 13, 2021, <https://www.beeple-crap.com/vjloops>.

science.¹⁶ Where the pondering question on which if architecture's main goal is to add pleasure or function. Who other to design St. Peter's Basilica but a cohort of architects, but artists above all?¹⁷

While inspiring as this new direction was, the realization that modelling each individual element really showed that the process was not only going to be time-consuming, but it presented itself as a taxing and power-hungry task, that would require a capable workstation and a significant amount of time. Even when attempting in using the assigned workstation for this project, it would definitely struggle with complex geometry and rendering settings. It consequently led finding an alternative to the goals presented. Fortunately, Derivative's Touch Designer¹⁸ became a reliable and interesting new platform that would enable interactive systems for music visuals. It also allowed for further development of networks that instanced geometry from taking information from audio itself. Ultimately, it became the better tool to segue into where the investigation was going. TouchDesigner ended up being the primary platform that hosts geometry networks that react in real time to the music that was produced using other programs. Networks that are self-generative, taking instruction from music, therefore creating its own environment and controlling its own parameters, with the future possibility of it being projected onto physical environments.

¹⁶ Carlos Sambricio and Benítez Esther, *Etienne-Louis Boullée: Ensayo Sobre El Arte* (Madrid: Instituto Diego Velázquez, 1972).

¹⁷ Turpin C. Bannister; The Constantinian Basilica of Saint Peter at Rome. *Journal of the Society of Architectural Historians* 1 March 1968; 27 (1): 3–32. doi: <https://doi.org/10.2307/988425>

¹⁸ ben Feb 21st 2020, "Touch Designer 2021 Official Update," Derivative, April 19, 2021, <https://derivative.ca/community-post/2021-official-update/63810>.

6. Future Ramifications

This study can be a lifetime exploration of possibilities. For a fact, future projects involving the principles studied will continue in using Touch Designer as a means for 3D visuals accompanying music. However, ultimately, the translation of such concepts would be intriguing and fascinating to experience in the physical world. The concepts explored in this investigation can be applied in a myriad of areas that would be fulfilling to study more in depth. Definitely, applications in Virtual Reality using immersive lenses and spatial audio would be excellent once the current global conditions allow where once can share VR headsets and have access to them. As well as the exploration of Augmented Reality applications, the reverse engineering of the wavetable concept discussed in this study, it would be absolutely phenomenal, where spaces can be scanned and in theory one could listen to the wavetable of the surface.

Additionally, creating installation pieces using 3D projection mapping would be another avenue on which this study could easily go for. Taking inspiration by the immersive work of artists such as Refik Anadol, not only change the architecture of a space but also reflects data in a way that visualizing information is not commonly known for. It also discusses the interconnected nature of pictures, dreams, memories and hallucinations while showcasing them in an immersive environment.¹⁹ Concepts that could be explored with the enhancement of music and shaping of space.

Whichever avenue is explored in the future first, it will definitely satisfy even deeper questions that could continue exploring the topics addressed in this study.

¹⁹ Refik Anadol, "Synaesthetic Architecture: A Building Dreams," *Architectural Design* 90, no. 3 (2020): pp. 76-85, <https://doi.org/10.1002/ad.2572>.

7. Conclusion

More than taking existing architecture and translating that into motifs that could be interpreted in music, the concept of space and how it can be created using color and form, instanced by music has been an enticing and insightful endeavor. Understanding the difference between making buildings and making architecture, focusing on emotions and spaces truly reflects how space visualization can be an artistic exploration on music, architecture and sound. The new programs and tools barely foreshadow the potential of what can be done in the future using different approaches to reach different results.

Research done in this study have led to visualizing spaces and playing within perception to create these sonic and imaginative environments with a collection of electronic songs that are each affecting its own space, controlling parameters, defining forms and limits, representing themselves. This is but a product that shows what can be worth exploring in both the physical and the virtual world and in the future blend them.

Consequently, one of the biggest reflections from this study has been the realization that everything human beings strive for end in a human desire for resolution. The worlds, the buildings, the cities we create are but a mere reflection of human desire, culture and direction. As artist Refik Anadol says:

In the stories we tell and the worlds we build, we continually construct mirrors that offer meditations on our identity while simultaneously becoming a part of nature itself.

This project has been focusing on blending two disciplines Jesús Pineda has been very involved in. A reflection of what he's done and in this investigation of blending both, the study transforms not to just visualizing information from music into 3D spaces, but rather a transformation of a desire for understanding both passions into an artistic experience.

Appendix

The process involved a combination of going back and forth between design and composition, which led to creating Touch Designer networks for four spaces/environments with its correlative musical piece. Different than the initial proposal, the timeline changed in relation with the difficulties and approach of the project. Table 1 reflects an approximate timeline for the course of the study.

Table 1 Gantt Chart

Project Tasks	December				January				February				March				April				May				June			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Design Development and Schematic Design In Blender																												
Touch Designer Training/Blender Trouble Shooting																												
3D Design Development/ Production for Music																												
Prototype Design Presentation																												
Documentation/Mixing																												
Shifting into Touch Designer																												
Revisions/Development																												
Final Submission																												

Resources

Resources and budget for this project can be seen in Table 2 and Table 3 respectively.

Table 2 Resources

Resource	Role
MacBook Pro 16"	Main Workstation
Hard Drives	Storage
Ableton Live	Main DAW for music production
Touch Designer	Prototyping and Visuals
Adobe Premiere	Video Editing (when needed)
Blender	3D Modelling software
Unity	Prototyping
Adobe Creative Suite	Design Visualizations
Serum	Sound Design/Visual representations
Studio Facilities	Music Production

Budget

Table 3 Budget

ITEM	PROPOSED	REAL
MATERIALS (disposables)		
Hard Drives	\$300	\$200
Memory sticks	\$50	\$50
Memory cards	\$75	\$75
EQUIPMENT		
HARDWARE		
MICS (Rental) 6 days	\$700	\$390
INTERFACE (purchase) 120 days	\$100	\$100
COMPUTER (purchase) 120 days	\$3,800	\$0
CAMERA (rental) 10 days	\$1,200	\$0
SOFTWARE		
ABLETON (purchase) 120 days	\$800	\$450
REVIT (per year)	\$2,425	\$0
Touch Designer	\$1,200	\$300
Serum	\$189	\$132
Adobe Creative Cloud	\$636	\$240
Blender	\$0	\$0
PERSONNEL		
MUSICIANS	\$1,200	\$0
ENGINEERS	\$3,000	\$0
MIXERS	\$2,000	\$0
EDITORS	\$2,000	\$0
STUDIO		
BERKLEE daily x # of days	\$3,600	\$0
HOME daily x # of days	\$400	\$0

OVERHEAD		
RENT	\$700	\$700
POWER	\$50	\$50
WATER	\$50	\$50
INTERNET	\$25	\$30
PHONE	\$25	\$25
FEES		
YOUR FEE	\$30,500	\$30,500
TOTALS	\$55,025	\$33,292

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