

Timbre Spaces: Interdisciplinary Education Between Architecture and Composition

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Within the close collaboration of an architectural design studio and a studio in musical composition, the students were asked to work in mixed groups of both disciplines to develop both a composition as well as an architectural design project. Starting from the analysis of an existing composition, the groups developed design and composition methodologies that could be utilized for the generation of both sound and geometry. Through the interdisciplinary projects we were able to identify possible relationships between the two fields on the levels of concept, methodology, composition and experience. While this interdisciplinary method of working may be less applicable for real-world projects, the required engagement with the other field and its ways of working and thinking has led to a challenging and fruitful questioning of the student's own disciplines' paradigms.

INTRODUCTION

Although music and architecture utilize different mediums for their manifestation, various theorists and creatives have proposed close relationships between the two. Projects from one field have been used as inspiration for the other, or work in both disciplines has been developed in close relation [1, 2]. In their verbal descriptions the disciplines share a multitude of terms, and philosophers and theorists attempted to formulate their connections [3].

Other educators tried to connect the two disciplines, often with architectural design studios based on a single composition as the inspiration for the design of a building [4, 5, 6].

Instead of this one-directional approach, we attempted an interdisciplinary collaborative studio of both architecture and composition students, working in groups of two architects and one composer. This exploration began with an analysis of a composition, and led to a generative method for the creation of both architecture and music so that the design processes could influence each other. Rather than using one discipline as the inspiration for the other, the goal was the creation of a singular spatial and sonic experience unable to exist without the other.

Lastly, an aim of the studio was the student's introduction to artistic interdisciplinary research: for architecture students to analyze work from another discipline and for all students to experience in depth another discipline's way of working – encouraging an engagement and understanding of the unfamiliar as a way to challenge preconceptions and prejudice.

BACKGROUND

Architecture has famously been referred to as 'frozen music' by Schelling, as quoted by Goethe, with the origins of this perceived relationship investigated by Pascha [3,7].

One common aspect that several works of each discipline have borrowed from the other are proportions and ratios, as has been explored in the Renaissance [8,9,10,11].

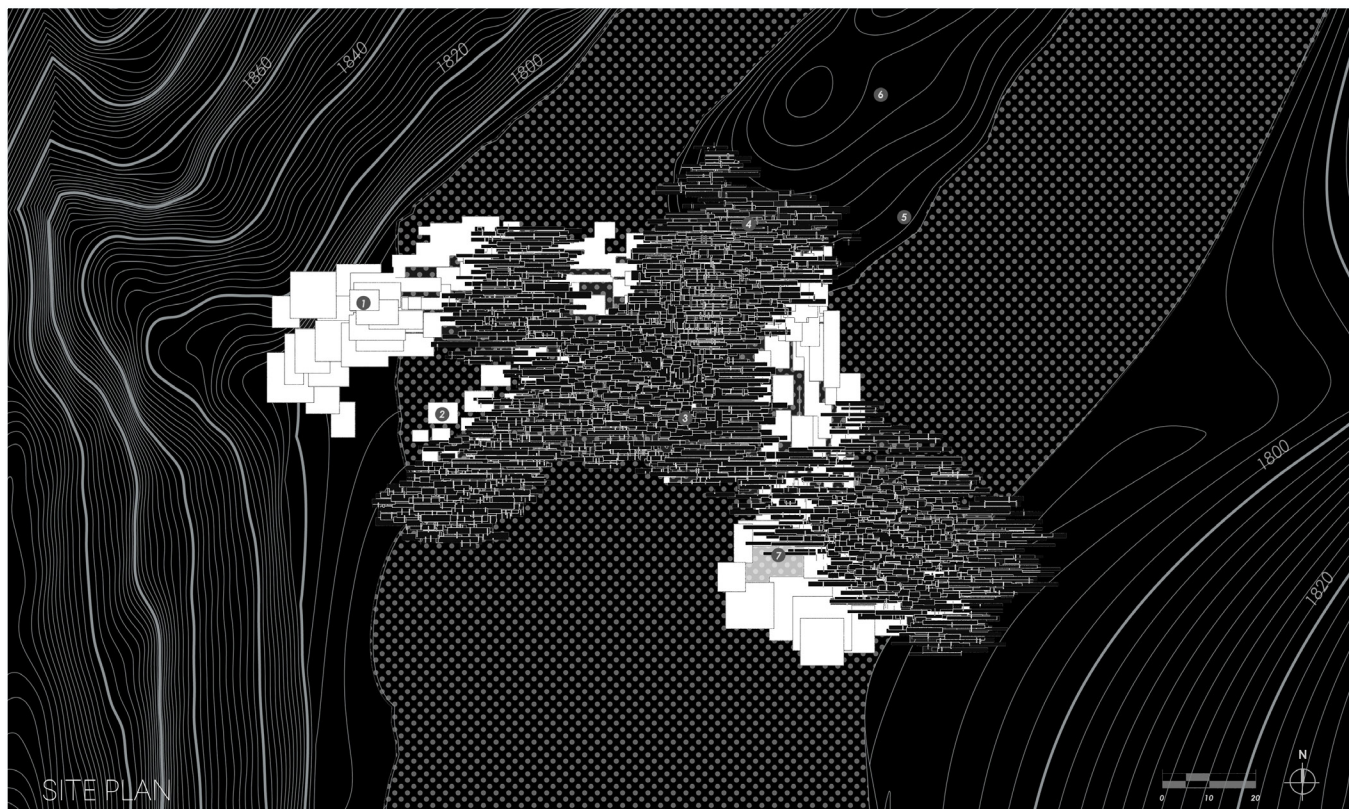


Figure 1. *Bi'an*, Plan.

Xenakis, trained as both architect and composer, developed the design for the *Philips Pavilion* under Le Corbusier in parallel with composing the orchestra piece *Metastaseis*. In creating both he was able to use the same methodology for the architecture as well as the music, the utilization of hyperbolic surfaces to create architectural geometry and orchestral clusters morphing from one state into another [1,1].

Zumthor explored the possibility of a space or a building becoming a musical instrument in itself [13,14], whereas Holl based the design of his *Stretto House* on the music of Bartok [6,2].

Various educators, especially from the field of architecture, tried to connect music and architecture, and studios at different institutions have attempted an approach based on music or sound. The projects often use a single composition as the inspiration or data that define an architectural design [2,4,5,6].

TEACHING METHODOLOGY

This exploration started with the analysis of an existing contemporary musical composition that was analyzed by creating a 3-dimensional diagrammatic space. Utilizing musical and acoustic analysis tools, this geometric representation was intended to be analytic in nature rather than generative. In a second task, this 3-dimensional space was then used as the basis to develop a musical composition.

This led to the formulation of a generative method for the creation of both geometry and sound so that the design processes could influence each other directly. Both analogue and computational methods were welcome. In a continuous back and forth between the architecture and music, the methods and the material they generated were then refined and arranged to form both a composition and an architectural design, to a student-defined site, program and instrumentation.

In each case the student group was responsible for choosing appropriate analysis techniques for the composition, and developing methods of generating new material in both domains, sound and geometry. Most of the original compositions for analysis were suggested by the faculty, but two groups chose their own.

The student groups presented work on three different review dates:

1. Analysis of a musical composition
2. Sound bit and Idea for Architecture
3. Review 3 – Composition

The final recital included a performance of the musical composition and a presentation on the collaborative work in a recital hall.



Figure 2. *Divided Densities*, Section

PROJECTS

BI'AN

Title of Composition and Design Project: *Bi'An*

Sound excerpt: www.youtube.com/watch?v=jisY2fF-NmM

Students: Xinlei Liu, Yunze Mu, Rugui Xie

Original Composition for Analysis: *Riverrun* by Barry Truax [15]

The project explored the possibilities of granular synthesis, a method by which material sound is broken into tiny segments which are then recombined according to stochastic processes to form other sounds. *Bi'An* translates as 'the other shore', and the syllables Bi and An formed the musical base material spoken by the composer himself, whereas the architecture used large white blocks as floors and thin black strips above. The composer as well as the architects investigated the potential of granular synthesis by using different parameters of frequency, amplitude, granular density, pitch shifting, possible ranges, sizes, and durations. Those were used to place the material probabilistically, transitioning from small to large, sparse to dense, wide to narrow and orthogonal to angular. The whole then emerges out of the cloud of individual grains, both musically and spatially.

Compositionally, both disciplines created a transition, musically by merging from one condition to another, and architecturally by forming a set of pathways across a river. Three sections can be identified as 'this side', 'between the two sides' and 'the other side'. Along this transition, both music and architecture start to form various particular spaces and situations that create specific atmospheres and programmatic locations, as different layers with unique timbres of sounds created through the granular synthesis allowed the composer to create a soundscape of river and shore. (Figure 1)

DIVIDED DENSITIES

Title of Composition and Design Project: *Divided Densities*

Sound excerpt: www.youtube.com/watch?v=tlIXqny1hkY

Students: Nick Clark, Carl Jacobson, Chris Jenkins

Original Composition for Analysis:

Aeriality by Anna Thorvaldsdottir [16]

This project explored the use of octree data structures to generate linked musical and architectural forms. In this methodology a complex curve was drawn which was populated with points at even distances, which served as the nodes of the octree. This resulted in a geometry of interlocking boxes, which formed the core of the architectural design. Musical material was generated from this same data by taking each box as a unit of time determined by its volume, which contained a number of musical events determined by the number of nodes within the octree box. The composer designed a program which could place these events either evenly or stochastically across their given time-period. This formed a musical base structure which was then expanded on by processing as set of delays, granulators, and filters.

These octree tools were combined with a large formal structure derived from analysis of Anna Thorvaldsdottir's orchestral work *Aeriality* [17]. The form of this piece is a relatively linear progression from clarity to density back to clarity via gradual aggregation and subtraction of pitch-class content. *Divided Densities* takes a similar structure, with a single motion from clarity to density, however in this structure density emerges from the spacing of individual percussive events in time, instead of a growing pitch-structure. Architectural density is modulated through size, material, and interlocking of octree boxes.

The composer encountered a challenge in the methodology because of the ways perception of musical events change as their density passes certain thresholds, where a dense series of sounds becomes fused in perception into a single sound-event. Also of particular interest and challenge to the team were the two disciplines different relationships to time. While the geometry of the architecture is time-invariant, the composition had to follow a timed path through the octree diagram. The possibilities which showed the most promise included following the original guide-curve, and reading the structure linearly from a two dimensional view. This second option better presented the large-scale change in density across the geometry, but also collapsed some of the detail included in the three-dimensional form. While both the musical and architectural projects resulted directly from the same octree structure, this difference lead to very different degrees of clarity in how the final product related to the original geometry. (Figure 2)

LUMIÈRE EXOTIQUE / CALMA, DA UCCELLI E FORESTE

Title of Design Project: *Lumière Exotique*

Title of Composition: *Calma, da Uccelli e Foreste*

Sound excerpt: www.youtube.com/watch?v=jw_KZM5T-1s

Students: Grace Choi, Brendan Girtten, Aaron Tkac

Original Composition for Analysis:

Oiseaux exotiques by Olivier Messiaen [18]

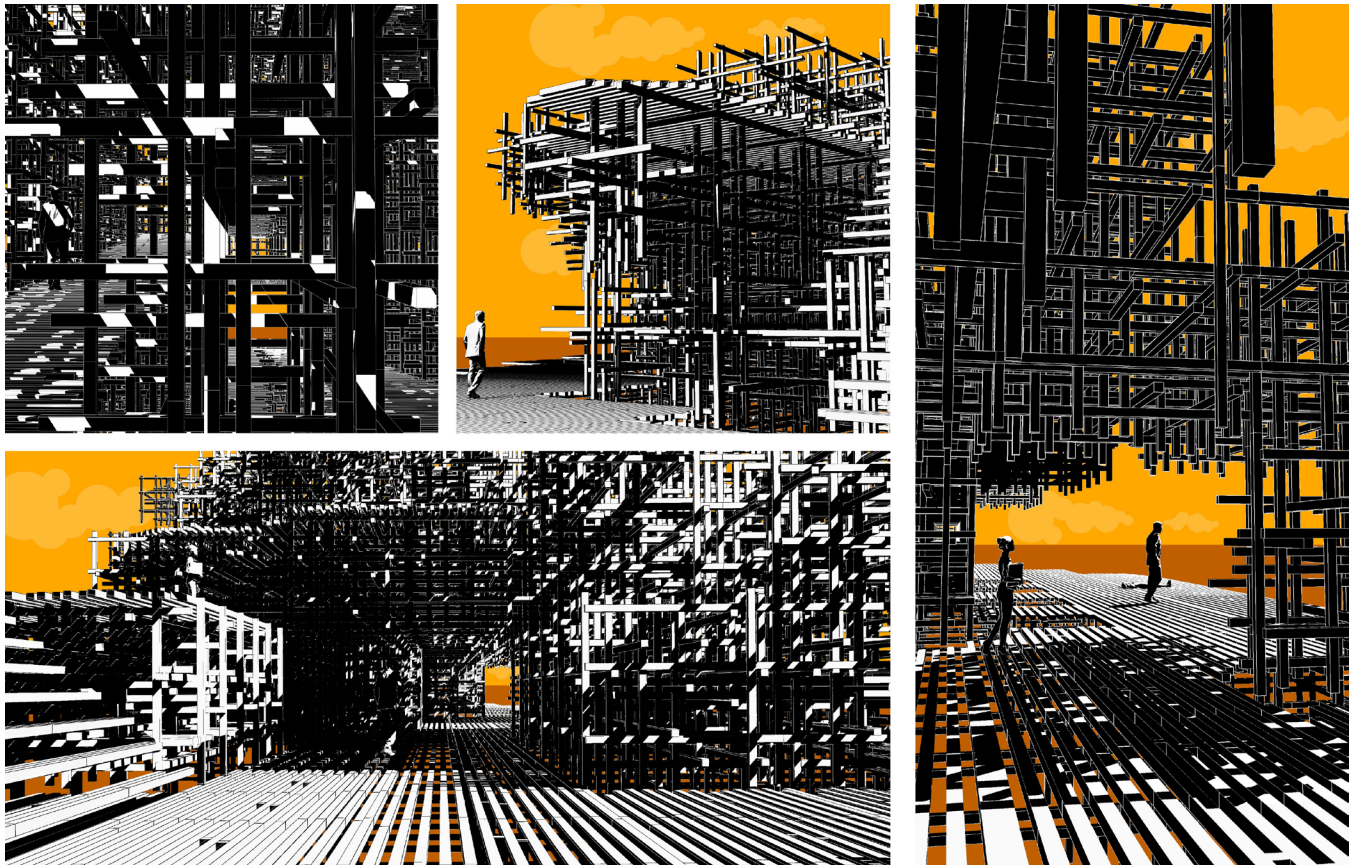


Figure 3. *Lumière Exotique*, Filtered Light

The analysis of *Oiseaux exotiques* by Olivier Messiaen revealed that timbre was altered by density of nature-based materials, and that form was created by rhythms and gestures. The strategy of this project was to use filtering to distort the mediums of sound in the music and light in the architecture. The filters were structured to give the listener and user a gradually more complex experience as a function of time, following the rise and fall of the daily sun path. Compositionally this was done by using methodologies of musique concrète, while architecturally a voxel system was defined that allowed for the creation of a dense spatial configuration of sticks that could be manipulated to create a variety of shadow and light situations.

The architectural result is a site-specific promenade guided by the musical composition in its response to the progression and experience of sunlight, with shadow and program composed along a path. The musical composition, *Calma, da Uccelli e Foreste*, has been shaped by the ideas of designing for site, circulation, and light through different densities of filters following the architectural progression.

The concepts for both the architecture and the musical composition are closely related: the filtering of a natural element to create a new experience. This concept forms the basic methodological process, but the specifics of each medium present

unique possibilities. The composition's materials were created with already-existing tools for filtering sound frequencies with particular constraints. Meanwhile, the architecture is the result of a tool that was created parametrically and specifically for this project and filters the light not by frequency but according to its distribution in space.

Despite these differences in the tools applied, there are two major, consistent driving factors for composition in both aspects of the project: site conditions and sun paths. For the architecture, the need to move down to the water and to wrap around the cliff face creates a spatial composition, while the sun paths help to compose zones of density based on its directionality. For the musical composition, observing the steepness of the cliff and the switchbacks required to move up and down defines the rhythms used, while the attention paid to the sun path and angles determines the arrangement of density zones of birdsong "conversations" and filter choices. The experiences within these zones are not directly related in the sense of a required interaction between music and architecture, however they are related in the perception of a natural element being filtered by artificial strategies. (Figure 3)

WALK IN THE WOODS

Title of Composition and Design Project: *Walk in the Woods*
Sound excerpt: www.youtube.com/watch?v=xV2rtncWZ6c

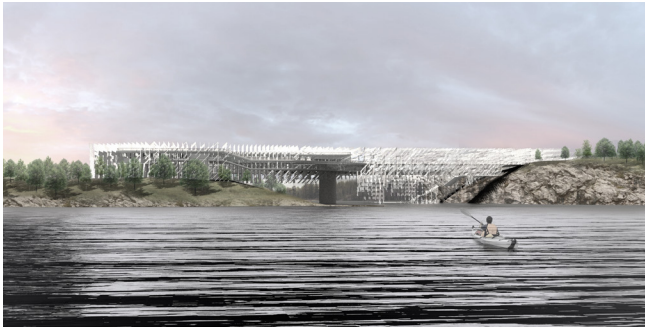


Figure 4. *Walk in the Woods*, Layering of Material

Students: Josh Funderburk, Damian McDaniel, Zhixin Lu
Original Composition for Analysis:
Ionisation by Edgard Varèse [20]

The initial concept for *Walk in the Woods* was inspired by Edgard Varèse's piece *Ionisation*. In his piece, Varèse used several groups of percussive instruments as the sources of the sound and organized them into different layers. The composer for this project took the idea of layering of sound with both acoustic sound and electronics. In this piece, three categories of sound were used: drones in the background, shorter gestures as the mid-ground, and granular synthesized and pulsed sounds in the foreground. All source sounds were either sampled or generated by analogue synthesizers. Likewise, the architectural project for a museum utilizes an overlay of heavy blocks for the large enclosed volumes, flowing horizontal spaces and a finer geometry for its structural system.

As a response to both Varèse's piece and the architectural ideas, the composer used some of the crucial ideas from the Varèse composition, but also created the music to coexist with the architecture. The sense of growth of timbral ideas is carefully controlled by a number of means. For example, sounds of the same character were grouped so that they were capable of changes in register and timbre and yet remained identifiable as a single part or line. The architectural structure was graphically reflected in the spectrogram of the music by creating specific ratios of fundamental frequencies and partials that move up and down analogously. In order to respond to the environment where the building is located, recorded wooden sounds were used in some parts of the music, while the synthesized sounds correspond to the concrete sections of the architectural structure. (Figure 4)

FEEDBACK LOOP / ARCHITECTURAL IMPROVISATION #1 FOR NON-ARCHITECTS AND NON-INSTRUMENTALISTS

Title of Design Project: *Feedback Loop*

Title of Composition: *Architectural Improvisation #1 for Non-Architects and Non-Instrumentalists*

Sound excerpt: www.youtube.com/watch?v=ok_Bj2aa5Mg

Students: Joel Garza, Erin Hunt, Alex Witteman
Original Composition for Analysis: *The Metaphysics of Notation* by Mark Applebaum [19], interpreted by John Lane

This project explored improvisation and notation as a continuous feedback between the architects and musicians. *Feedback Loop / Architectural Improvisation #1 for Non-Architects and Non-Instrumentalists* started with inspiration from Mark Applebaum's *The Metaphysics of Notation*, to a spectrogram analysis of John Lane's interpretation of the same piece. Initial architectural collages were created and subsequently used by a group of musicians to improvise to. The project went through a series of trial and error procedures, including many improvisatory sessions with a chamber group of percussionists.

The recordings were then used by the architects to create a 3D model, that again formed the basis for the next round of musical improvisations. Each session resulted in a further developed 3-dimensional design that in turn resulted in the next iteration of the improvisation, each one building on and reacting to the last. In the 3D version, the groups of musical instruments such as woods, metals, small hand-held percussion etc., where themselves represented as aggregates of 3D units in a space.

In a continuous back and forth, both music and architecture were shaped and adjusted mutually, with any change in either medium resulting in a change to the other. The initially free improvisation became gradually more controlled, with instruments, events, feelings, the direction of time and the common A-B-A' arrangement, interpreted as a bridge, becoming defined. Throughout the improvisatory sessions, different performative angles were used such as freedom of interpretation, direction (left to right, up to down, etc.) of reading the graphic score, time spent as a group discussing the score or even how much time was spent seeing the score before performing it.

After several redirections and tweaks, the presentation of the composition entailed a structured improvisation from the chamber group to a sectional walk through of the space the architects created. During this performance, the architects improvised by constructing a model live on stage using wooden slats, PVC pipes, clay and hot glue guns.

In this process, architectural sections turned into musical notation and sounds turned into spaces. The end product, however, turned out as refreshing and thought-provoking as the students had envisioned. The two groups from different disciplines that would have otherwise never worked together so closely made it a point to do so, with the unexpected discoveries and results such as being able to play through a space created entirely through musical, human, and mathematical improvisation. (Figure 5)

EVALUATION

Each project was the result of the particular composition that was analyzed, and the skills and interests of each group. This

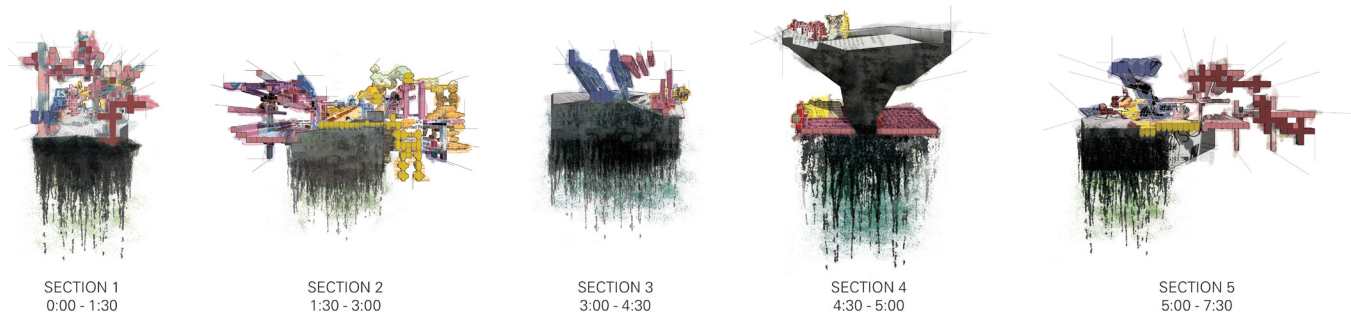


Figure 5. *Feedback Loop / Architectural Improvisation #1 for Non-Architects and Non-Instrumentalists*, Section Drawings and Musical Notation

resulted in widely varying projects with respect to the collaboration. A discussion of the five projects listed above will clarify some of the issues.

Bi'An successfully presented the concept of transition or movement across in both domains. The granular synthesis composition techniques which are based on gradually changing probabilities are appropriate for creating a multitude of unique gradually changing timbres, and resulted in a novel technique for the definition of architectural form. Scripting in the RTcmix computer music language produced complex changing timbres which were layered and mixed to produce the composition, while the scripting in Grasshopper provided a good control over the architectural probability parameters. The choice of fixed format audio was ideal for flexibility in different layerings which provided diversity in timbre.

The project *Divided Densities* had a clearer connection in methodology between disciplines, as both were based on the same octree structures. The larger form was based on the analysis of Thorvaldsdottir's *Aeriality*, while the octree structures generated detail. However the interpretation of the structure resulted in different relationships between the results in each domain and the original octree structure. Scripting sound events allowed precise realization of node data. Issues of perception had to be taken into account in both sound and space, as events that are very close together "fuse" in the listener's mind or blur into a solid mass of material.

The project *Lumière Exotique / Calma, da Uccelli e Foreste* was based on nature – the path of the sun and light on the architectural side, and the presentation of birdsong in the musical composition. Filterings were the methodology used in both domains, to transform basic material, however the filtering in music applied to the frequencies of the sound, whereas the filtering of the light pertained to its distribution in space. The listener/viewer's experience was a primary concern in this project.

The architecture and music were less closely related in *Walk in the Woods* compared to some of the other projects. The idea of

layering different sounds or different architectural elements is a relatively general concept that did not develop to a very deep interdisciplinary connection. However on the geometric level there were interesting correlations between the final building design and the spectrogram of the composition.

The project *Feedback Loop / Architectural Improvisation #1 for Non-Architects and Non-Instrumentalists* had the most serious challenges, since the original work analyzed was improvisatory and unfolded differently every time without even precise specifications of instruments. The group experimented with different methodologies, and finally settled on constructing an improvisation in both the architectural and musical domains. The composer is a percussionist, and organized an improvisatory performance of a percussion ensemble. The architects performed as well, creating an architectural model as part of this performance.

In general, some of the challenges of the studio, which sometimes generated learning successes, were the acceptance of the other discipline's evaluation criteria and modes of working, questions of how to apply a methodology to both sound and space in a coherent manner, and how to deal with discipline-specific questions such as constructability in architecture or harmonics in music.

Notable was the difference in working practices between the disciplines. Even an architect's very first sketch usually attempts to describe the complete building, which then as a whole gets revised and becomes more and more refined during the design process, whereas on the contrary the first sketch of a composer is more likely to be a small musical segment that gets added to while being developed until the whole composition is assembled.

The interdisciplinary nature of the course certainly formed a challenge for the students to work together, but especially to consider and to argue for the relevance of the collaboration and each discipline's criteria that render a project a success. The students cited "excitement, nervousness, curiosity, and uncomfortability throughout the entire process", with fundamental questions of the value of collaborating "constantly looming on our minds".

Also there were differences in the programs in composition and architecture that presented challenges in teaching a collaborative course. The 3 credit, 3 hours per week composition course had mostly graduate students, while the architecture course was a 6 credit, 12 hours per week undergraduate capstone studio. While the architects were hoping for more time with the composers, the latter sometimes felt expectations to go beyond the usual 3-hour course.

Due to the student numbers, each group had two architects and one composer. While architecture commonly happened through extensive collaborations, composers most often work alone and had to learn to work more collaboratively. Group work, as usual, sometimes leads to great collaborations, but may suffer from interpersonal difficulties. We observed groups that interacted intensely, groups in which mostly one discipline attempted to take and learn from the other, as well as groups where the collaboration was limited to the joint presentation of the works. The unfamiliarity with the other's subjects in some cases led to a questioning of working methods and even isolated disrespect, while also new friendships formed between students.

The intentions, thoughts and methods of working in one discipline may easily be misunderstood or misinterpreted by someone not specifically trained in this discipline. We found that some groups did not always choose the best presenter for a particular topic, perhaps due to a lack of awareness of the differing skills of each discipline. For example, in a review an architect instead of the composer might be charged with discussing the music component, which could result in an inaccurate description of the music.

Through the student's projects we were able to identify, non-exhaustively, different categories of connections between the two disciplines, which appear to be relevant for interdisciplinary translations also beyond the work of the studio:

- Concept: An inspirational concept the work deals with that does not form a methodology (such as 'traffic' or 'nature')
- Methodology: The utilization of a common methodology for the generation of raw geometric and sonic material.
- Composition: The arrangement of material on the local and global scale by borrowing proportions from the other discipline, a common theme observed in some of the other musical studios [4, 5, 6].
- Experience: The experiential emotional level of being in a space or listening to a piece.

Interestingly, 'style' does not appear to be one of those categories. While bound by various constraints through the collaboration, these were not able to direct the students in terms of analogue vs. digital, straight vs. curvy, harmonic vs. dissonant, or even ornamental vs. minimal. The actual choice

of style of each work therefore remained within the domain of each discipline.

In all of the projects the fundamental difference in how time functions in architecture versus in music had to be addressed. While many of the materials of both music (scales, pitch sets, spectra, etc.) and architecture (geometries, building materials) do not have predetermined relationships with time, the way they are experienced do, as the listener/viewer encounters the beginning of the composition before the end, and the point that they enter the architectural structure before the next position they take within the structure. Much of music consists of events unfolding in time, whether they are exactly the same in each performance/presentation or not. In the case of fixed format audio, the events are precisely prescribed in time. The relationship to time of the architectural structures was different in each case, depending on how much freedom the viewer had in moving through it.

We also realized, in the work of the studio as well as outside of it, that care must be taken to evaluate to what extent the work of a different discipline has actually been taken into consideration for a project by a creator who makes that claim. It appears that often the music may have remained no more but an abstract 'inspiration', resulting in the purely subjective impression of the designer. Particularly in architecture it is often imperative that a design be explained through an interesting story, in order to obtain the approval of a professor, a client or the press. A suggested relation to music may result in this story, but it may often be no more than post-rationalization or an attempt at marketing.

Even though the aim of this interdisciplinary exploration was a cross pollination between music and architecture, most of the groups certainly surprised us in developing unexpected and novel concepts such as the application of common tools from one discipline to the other, improvisation of architecture, or mathematical and stochastic processes.

CONCLUSIONS

Overall we regard the course as successful, as the students were able to create interdisciplinary work that they would not have been able to create without this close collaboration. They were compelled to understand their partner's work and find connections between working methods. The challenges were sometimes frustrating, but there has been enthusiasm for another course in the future furthering the connection between music and architecture. The interdisciplinary collaboration and their resulting projects may not directly be applicable to real-world requirements, however we regard the challenging of conventions, of traditional modes of working, the broadening of creative thinking as paramount to any education in the creative fields, and we suggest that more interdisciplinary explorations be attempted in liberal and professional arts degrees.

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