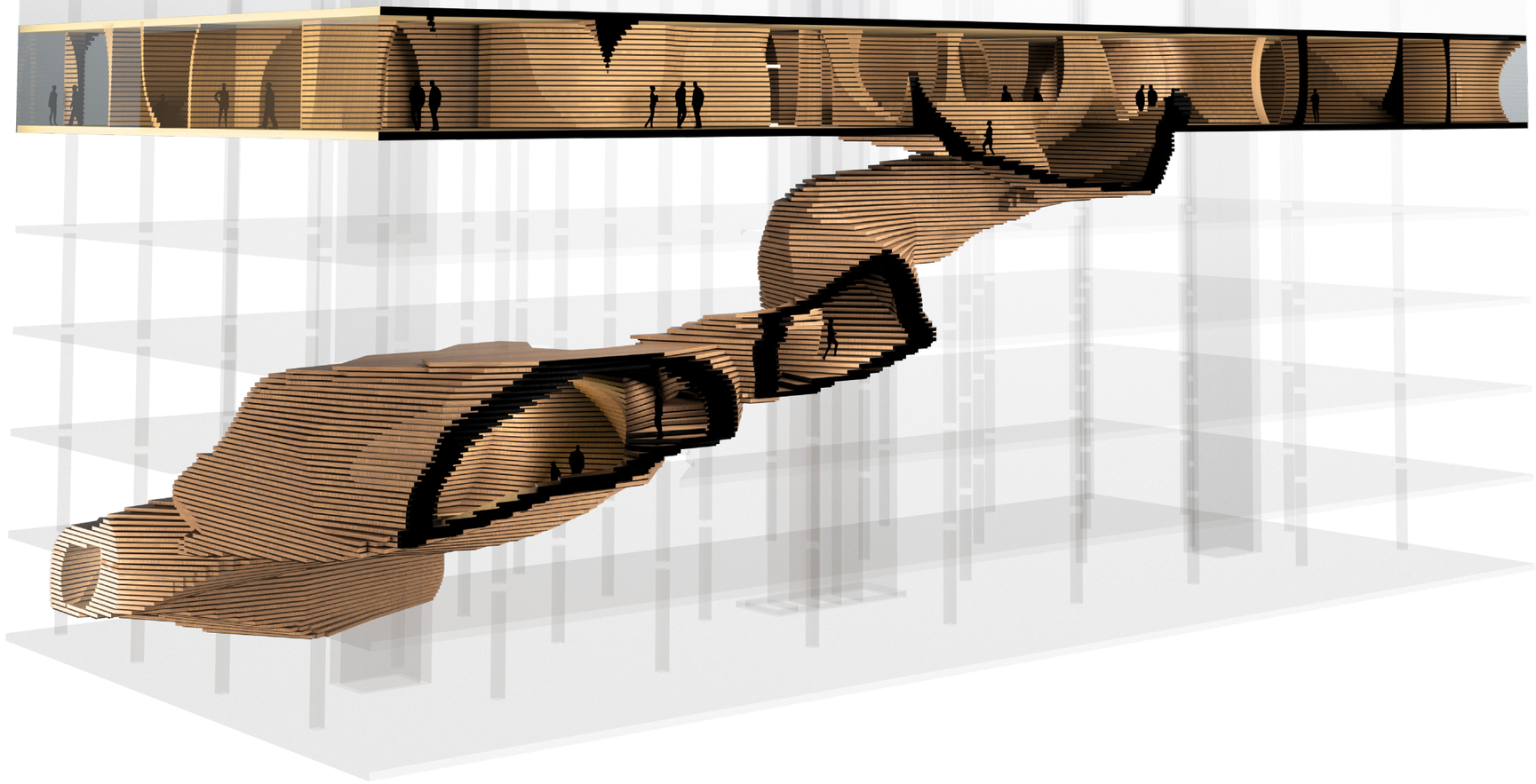


Lamella

Acoustical retrofit of existing floor and a stairway as venue

Spring 2019 | 3rd year Bachelor

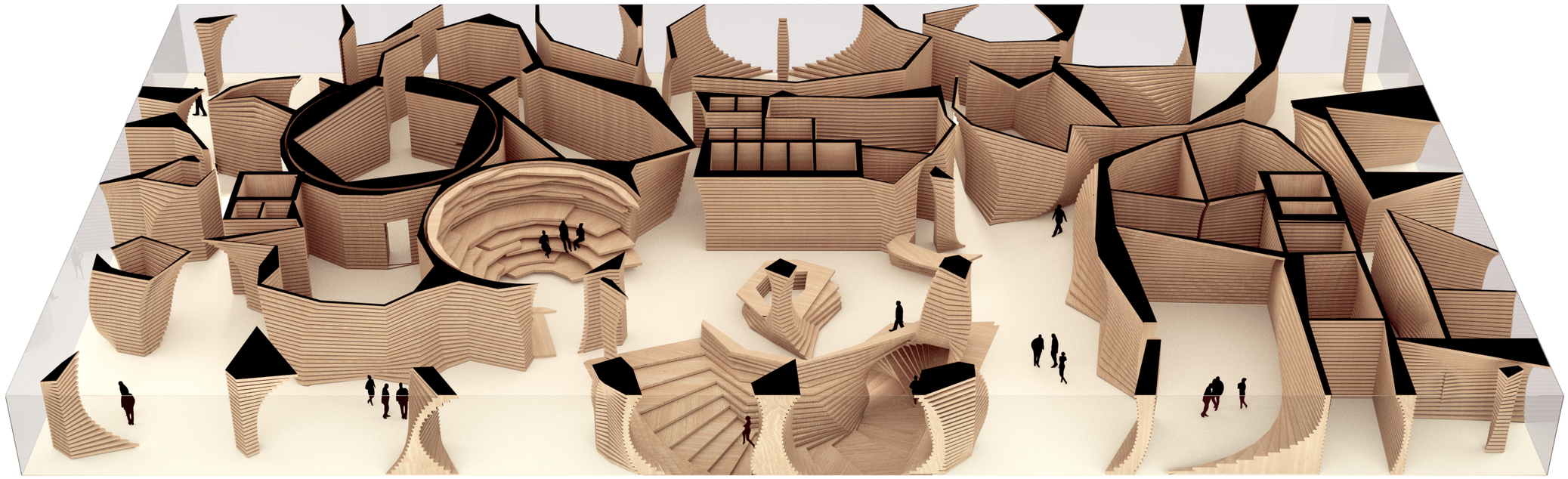
Grasshopper | Rhinoceros
Photoshop | Vray

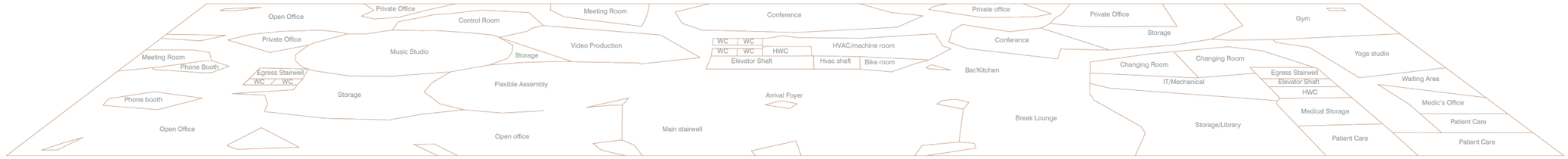
Program

Acoustical Society of America announced a student competition for a retrofit of a floor in an existing 15 story building. We participated in the competition but expanded the program to also include a small, informal venue for music and lectures in the main stairway.

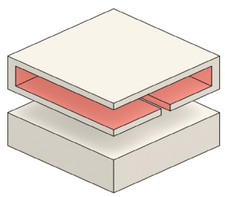
Concept

The main element used for this retrofit is the wooden slab. Equal in height, every straight slab repeats itself in elevation, but gradually revolving and growing around desired paths to form organic spaces by playfulness and surprises. The inherent flexibility of the concept is used to satisfy the desired characteristics of each room with a wide range of possible surfaces, spaces and properties. While the qualities of each room is adapted individually the concept of the lamella structure is keeping a strong and coherent visual identity for the office and media company.



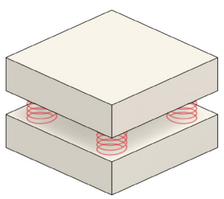


Helmholtz resonators



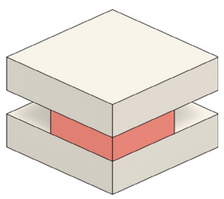
Absorption of low frequencies is handled by integrating cavities inside the slabs to act as Helmholtz resonators. The opening to the cavity is hidden in the gap between the slabs and filled with porous material.

Vibration isolation



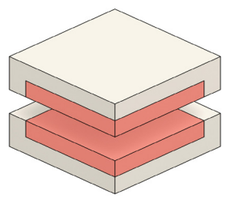
Room-in-room construction can be created by placing springs or elastic interlayers between the slabs.

Porous absorbtion



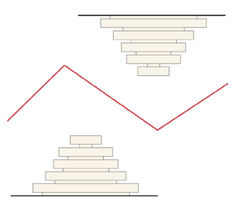
Porous absorbers made from hemp wool are placed in the gap between the slabs in areas where absorption is needed. The placing inside the gaps protects the absorbers from accidental damage.

Variable acoustics



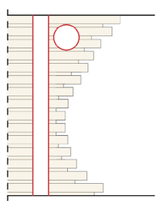
Where walls are mechanically variable the slabs slide and gaps open up to expose absorbers hidden on the horizontal surfaces of the slabs.

Sound propagation



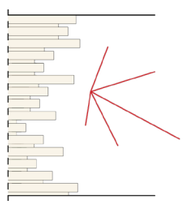
Stacked slabs form partition walls which break up the full height of the rooms to control sound propagation by breaking direct paths.

Encapsulation



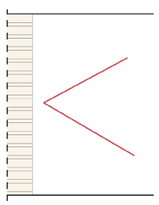
Separated by an elastic interlayer, the slabs wrap around structural elements and ventilation ducts to reduce sound and vibration propagation into the room as well as the excitation of vibrations in structural elements.

Diffusion

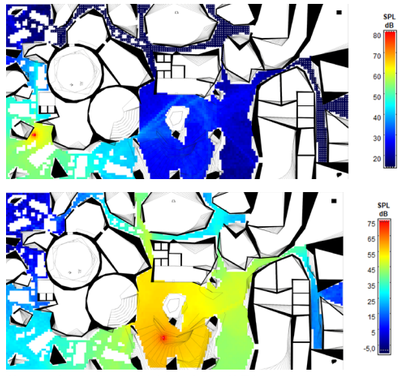


The slabs form an irregular pattern both in horizontal and vertical direction when diffusion is needed. Avoidance of periodicity provides an even distribution of diffusion.

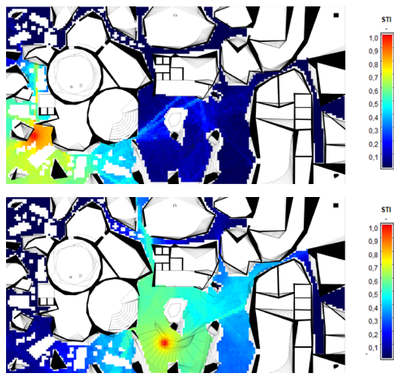
Reflektion



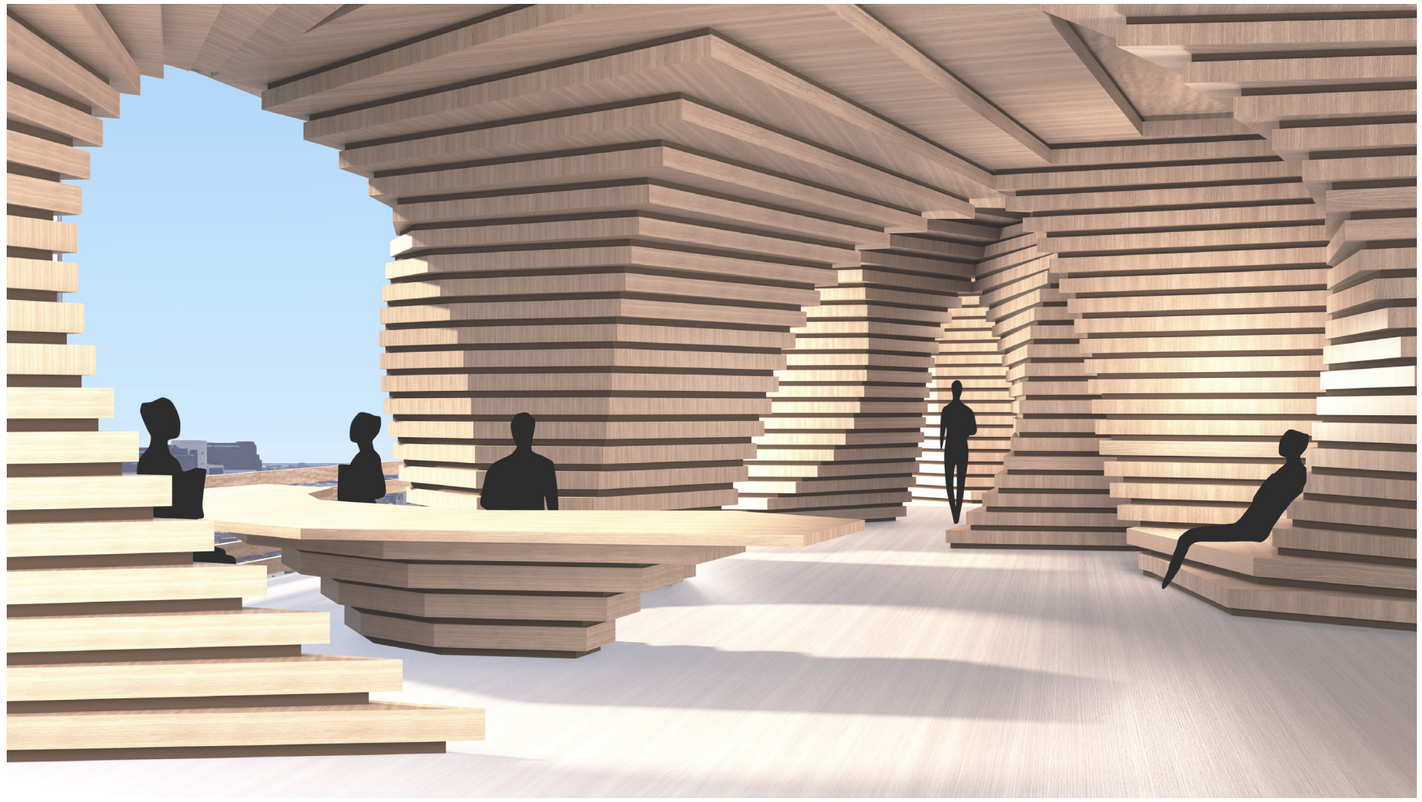
The slabs form a flat and acoustically hard surface where merely specular reflection is needed. Slaps with hard surfaces can alternate with slaps which provide absorption



Sound pressure level - SPL



Speech transmission index - STI



Office

The office design revolves around the acknowledgement of the range in which humans perceive and prefer their working environment. Not only different between people but also personal preferences, changing throughout the day. The individual opportunity of selecting his or her working time and place is therefore the main premise of the open office. Opposed to personal workstations this enables a wider range of varying properties available for the employees to find the sweet spot between communication and concentration, direct sunlight and complete darkness, disturbing loudness and uncanny silence, etc.

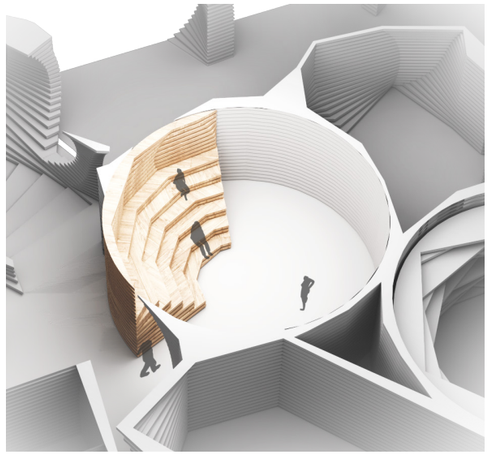
To achieve a gradual change in spatial, environmental and acoustic qualities the office plan is tightened down in width and stretched out in length, revolving around the recording studios following the façades of the whole western half of the building, from south to north.

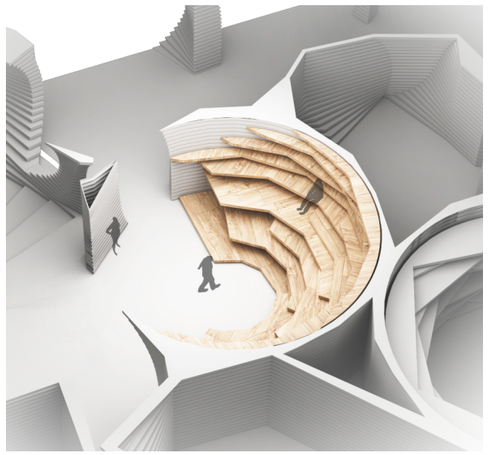
The south part of the open office provides a direct connection between the lively lobby and assembly area to the rest of the office. Both visual and audial connection to movement and activity crates a stimulating atmosphere filled with impressions and spontaneous meetings. The relatively large uninterrupted floorspace lets the southern direct sunlight far into the room.

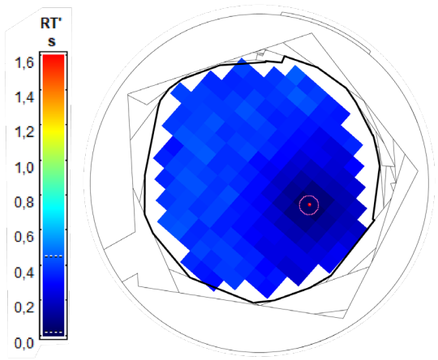
The organic structure of the interior walls guides the movement further along the western façade. Here the space is broken up by the undulating walls forming enclosed spaces as private offices and conversation booths, scattered around the winding passage. Here, the ceiling height is lowered and passage tighter to slow down movement and hinder sound propagation and direct sound reaching further into the office. Between the small office rooms, semi-open spaces form, offering the dampened but still present connection to the rest of the office. Same principles are used along the northern façade where the largest conference rooms are located.

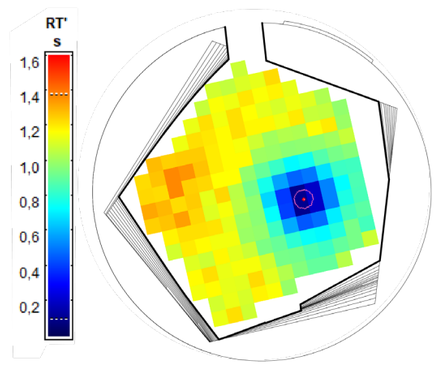
The meandering office paths ends up in the north west corner where the open office reach its furthest from the main sources of non-enclosed sound sources. Naturally this space is also characterized by the low prevalence of passing people. Together this is forming a space on the end spectrum of the sometimes conflicting communication and concentration relation.

The distraction distance as defined in ISO 3382-3 is <10 m in the more lively areas of the office and lies in the recommended range of <5 m in the calm areas. Sounds from the assembly area are <48 dB(A) in all parts of the office area. The A-weighted sound pressure level of speech at a distance of 4 m is <48 dB(A) in the calmer areas of the office as recommended in ISO 3382-3. The triple layered glass façade with noise protection class 6 all around the 6th floor is preventing community noise from having a negative influence on the working atmosphere.









Flexible Assembly Hall

By the winding stairs or elevator, you reach the 6th floor in the arrival and main circulation area. Here in the center of the floor people are in motion. Work is dissolved into movement and short social interactions. People starting their day, heading for a coffee or yoga brake, people in rush to a telephone meeting. From here the organic wall structure and the glimpses of natural light encourages the employees and visitors to explore further into the building to the rooms and offices along the glass façade.

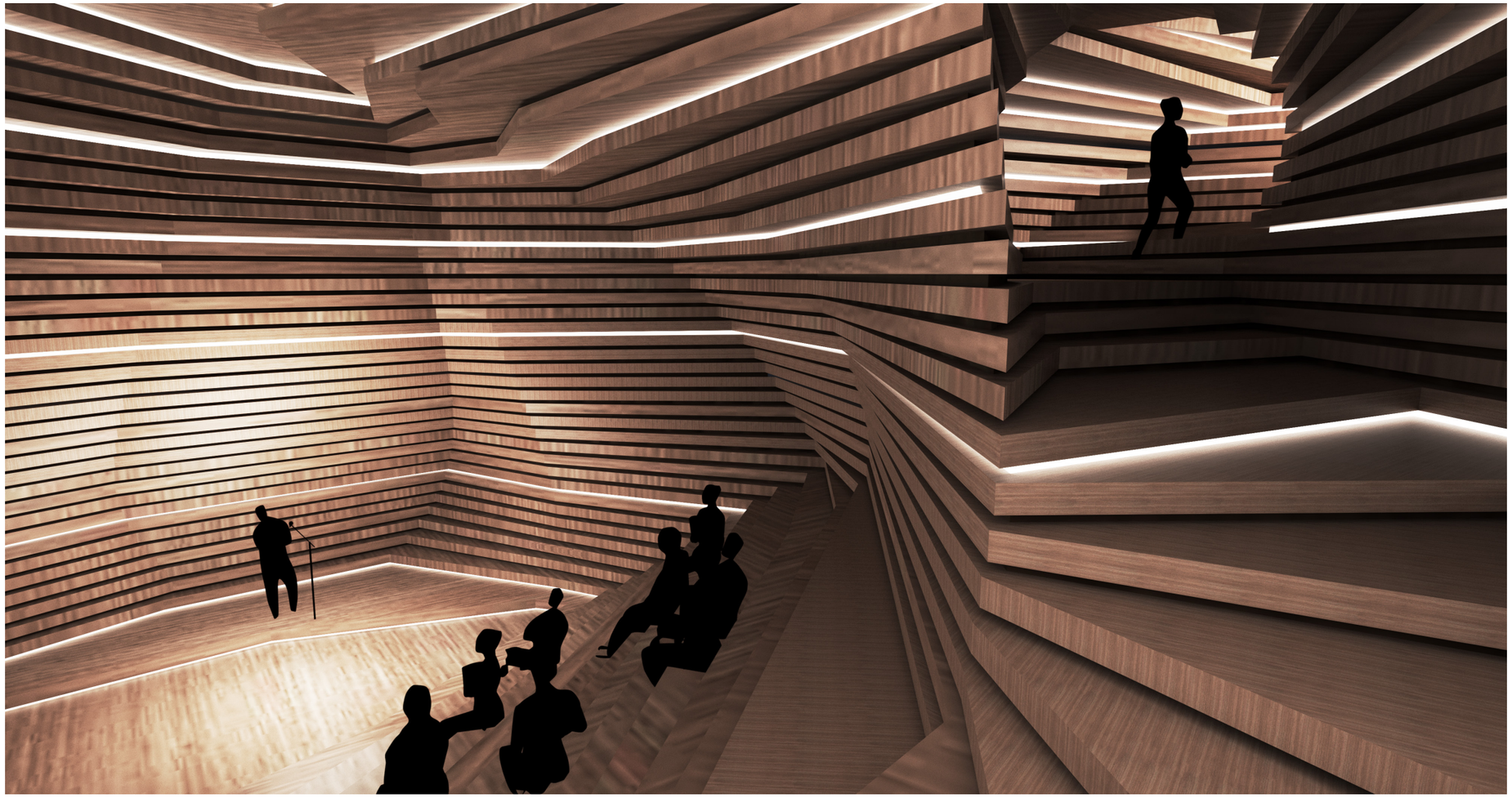
Adjacent to the lobby and open office the slabs form a circular room offering two different modes, catering different to different activities and occasions. As a casual hang out space or large company wide presentations the half circle of seating is facing outwards towards the large open floor of the lobby. For a more enclosed gathering the slabs are rotated directing the seating inwards and closes of the room from nearby distraction.

Music Studio

The music studio is highly adjustable acoustically, spatially and topologically. Rotating slabs transform the room from an organized pentagon shape into distorted horizontal wall fragments. From an open rehearsal area with reflective vertical, wooden surfaces it morphs into a qualitative and spectacular recording setting, exposing porous hemp wool absorbers on horizontal surfaces and creating significant diffusion. Some openings of the Helmholtz resonators, which are integrated in (some of) the slabs, are located on the perimeter of the slabs and therefore active in both configurations. In the recording setting the reverberation time is reduced by a factor of almost three and is then between 0.2 s and 0.3 s in the frequency range from 125 Hz to 4 kHz. The rotation allows for more configurations than these two extremes giving a playful opportunity to reach any values within the range by adjusting the degree of rotation.
With aligned slabs in the rehearsal setting there is provided a door opening through which the room can be entered. This opening warps away when morphing the room into the recording setting and opens up a window to the control room.

The music studio, control room and video production suite are room-in-room constructions elevated on springs to achieve isolation from structure-borne sound. The cavity of the room-in-room construction is filled with hemp wool to further increase the sound reduction of this double wall construction. The mass-spring resonance of the double wall is placed below 15 Hz and thereby the sound pressure level is reduced 75 dB at 100 Hz.

The video production suite is neighbouring the previously mentioned rooms but relies on it's own room-in-room construction. Helmholtz resonators and porous absorbers made from hemp wool are conveniently hidden in the gaps between the wooden slabs.



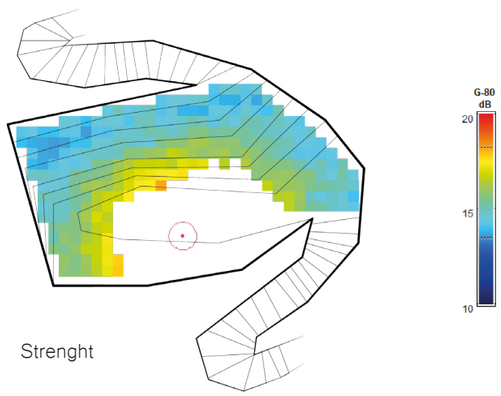
Stairs as a Venue

Starting at street level the repeating pattern of horizontal slabs is guiding the visitor upwards through the partially repurposed parking garage. The slabs are hollowed out to encapsulate a dramatic stairway connecting the street to the office, six floors up. The removal of the façade under the 6th floor makes the identity of the office visible to the passing people in downtown Louisville. Creating an event in itself, the stair also widens halfway up forming a small intimate venue for acoustical music or performances.

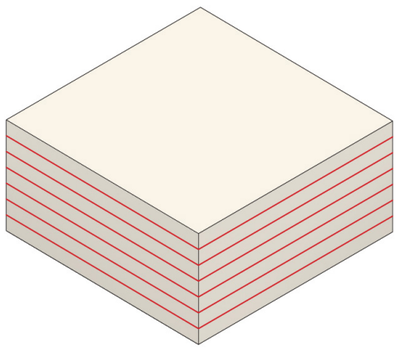
In the venue, some gaps between the wooden slabs are filled with porous absorption and Helmholtz resonators to control the reverberation time while the wall structure naturally acts diffusing. Thereby, the reverberation time is kept between 0.7 s and 1.0 s in the frequency range from 125 Hz to 4 kHz.

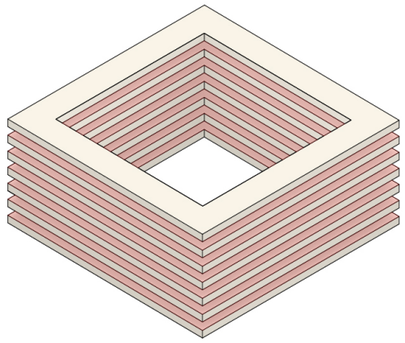
This rather low reverberation time is suitable for the ~700m^3 small venue and creates an intimacy which is further increased by the closeness of all positions in the audience area to the performers. This also provides a high sound strength for the whole audience which makes a natural experience of sound without electrical amplification possible. The speech transmission index is 0.58 at the worst position in the audience area, which indicates a fairly good speech intelligibility without making the room to dry for musical performances.
The entrances to the venue are designed as long, narrow and winding paths with highly absorptive walls which reduce the sound pressure level by 50 dB and thereby prohibit sound from reaching the office without the necessity of doors.

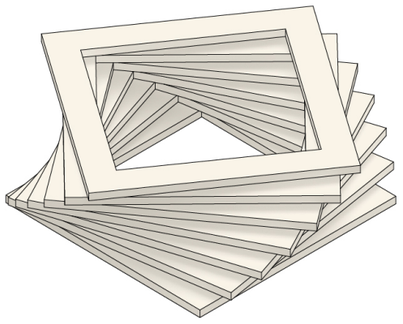
The gaps between the slabs are also used to provide lighting to the stairway, complemented by window openings where the curving volume meets the boundaries of the building.



Strenght







Reflection

The objective was to combine our previously acquired knowledge of architectural design and technology, making them enhance each other in a holistic project. It specifically meant implementing strategies for acoustical properties as well as building technology in our key design concept.
Our starting point was the smaller venue connected by a winding stairway. The continuous passage up to the sixth floor was an important piece in the puzzle of evolving our design concept of horizontal plates. Another acoustical concept we conceived in an early stage was that of mechanically adjustable elements. The vision was to rotate all slabs individually to create an acoustically variable venue. This idea was later used in the music studio and the flexible assembly hall.

Our result was heavily influenced by our strict but highly applicable set of rules. Within our design we could mold each room in a desired way, provide integrated and hidden details for ventilation and acoustical elements, create playful paths and elegant, swaying vertical curves. Spatial qualities include informal rooms in many configurations and rooms of both well defined and more open characteristics.

I'm more than satisfied with our design approach and the ideas we evolved were convincingly solving most problems asked for in the program. I wish we had worked more with the floor, specifying a design method for it or at least question the design more when applied on the floor. The horizontal plates are functional for acoustics but aesthetically they might have been too extreme in their appearance. Making the whole floor more of a peculiar sculpture than a retrofit for a floor. However, our consistency of maintaining the concept throughout the entire project is a major strength and proves its utility.
Communicating our project was demanding, partially because of its very irregular 3-dimensional nature. The floor would be misunderstood if simply represented by a 2d plan and we opted for a perspective plan. Furthermore, the mechanically adjustable rooms were presented using a simple and striking animation of the movement.
Collaborating with acousticians and my partner in this project has been joyful. Our process has been forgiving and explorative, coming up with, and accepting new proposals until the very end. Understanding the complex world of acoustics was difficult but enlightening and I will be humble but curious and inquisitive when in collaboration with other professions in the future.