

Municipal hall, Tuscon, Arizona,
Bachelor Project, spring 2018
Competition entry, pending
Integration of acoustical design

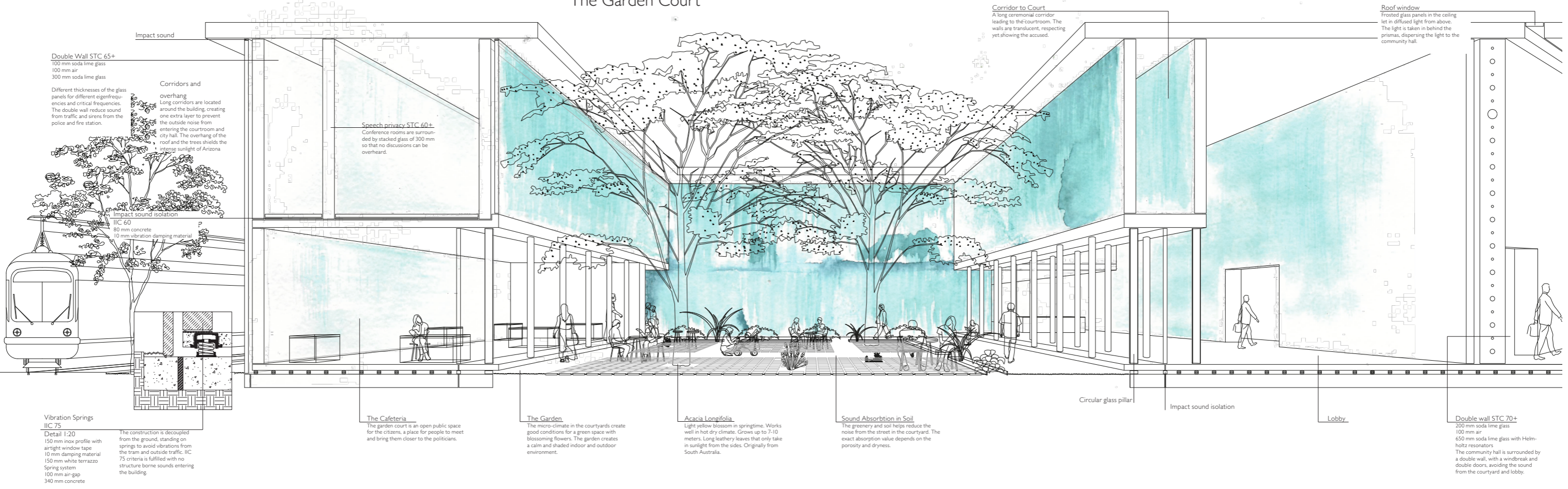
CRYSTAL HALL

A translucent City Hall, for a transparent democratic system. A design collaboration with Clara Havström and acoustic students Anand Kelkar and Tom Houterman that has worked very well. Starting the project with Clara and a clear set of goals we made it almost all the way. A lot of time collecting materials and clarifying a precise vision and a core set of values, looking into different materials and ways to get there, researching the plans of old city halls as well as contemporary architecture became the key in the starting process, and then the ability to decide and go for and select one of three concepts. Early phase was a lot of experimenting, even though I myself could have been more active in the start, we did good in analyzing the work we had done, which made it possible to iterate and develop to get three concepts out, similar in vision, but architecturally different. The openness when including the acousticians and aiming for fast calculations and try out made a very good collaboration happen. Mid phase should in retrospect have been more intense and we should have been better to stick to our deadlines to be able to actually iterate our presentation work once more, especially when it comes to model photos (and everything else)



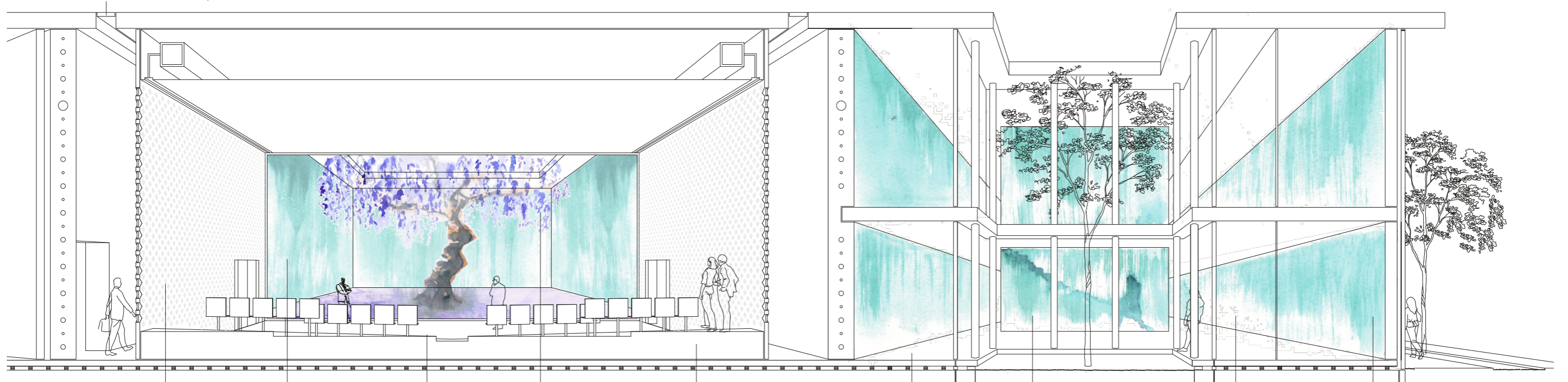
Model Photograph of the back in the Community Hall, the variable crystal wall 1:20

The Garden Court



The Crystal Hall

City Offices



Community Hall
Seating 238 people
Volume 1750 m³
1.05 sqm/person

Double Glass Window STC 65+
20 mm insulation glass
66 mm helium
16 mm insulation glass
A highly reflective wall behind the stage helps the sound to reach the audience.

Wedding Aisle
A large centered aisle for special occasions and weddings.

Blue Jacaranda Tree
Purple blossom for more than 8 weeks in spring. Prefers bright sunny conditions, enriched sand and moisture but tolerates drought. Grows up to 20-30 meter. Originally from Central America.

HVAC System
Behind the community hall is a plenum silencer, on the first floor. It allows a slow airflow of fresh air that sippers up underneath the seats and is collected through air-curtains along the sides of the ceiling.

Rear Entrance 2.5 m
A corridor large enough to transfer a grand piano and other large objects.

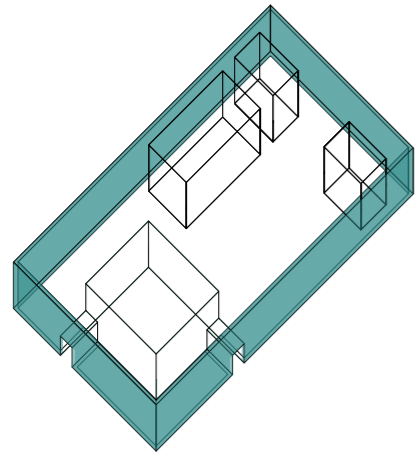
Sun Chimneys
5 mm black steel
300 mm air-chimney
20 mm glass

Natural airborne cooling system. Dark panels directed towards south heat up the air in the chimneys and creates a natural airflow in the building. The chimneys goes down into the ground cooling the air. All channels are decoupled acoustically from the structural system.

Elevators and technical rooms
Elevators are acoustically decoupled from the load-bearing system with an air-gap between the doc and the floor.

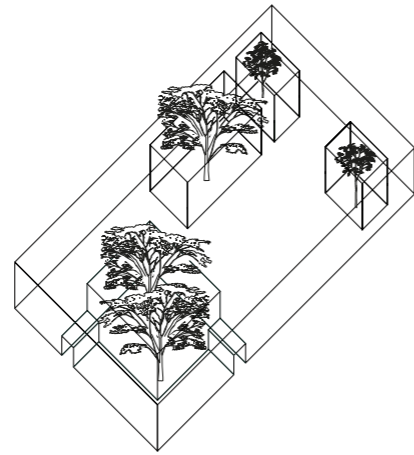
Technical rooms have thick double walls and vibration springs so that no noise is transmitted through the structure.

Working Environment
Large windows towards the atrium creates an open and pleasant working environment in the office.



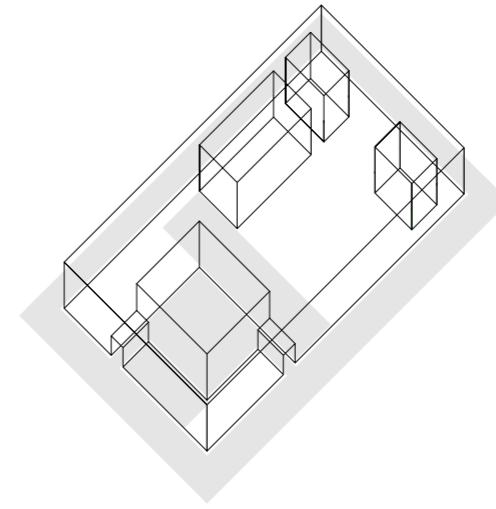
Glowing with focus inside

Stacked panels of soda lime glass creates a translucent, but not transparent building. The building lights up in the night thus keeping focus inside the Court and Jury room.



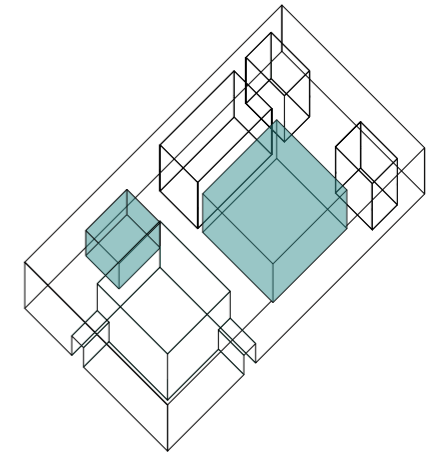
Garden courtyards

The views out are all directed to the four garden atriums for a relaxed and calming atmosphere. The garden court provides an oasis to the city.



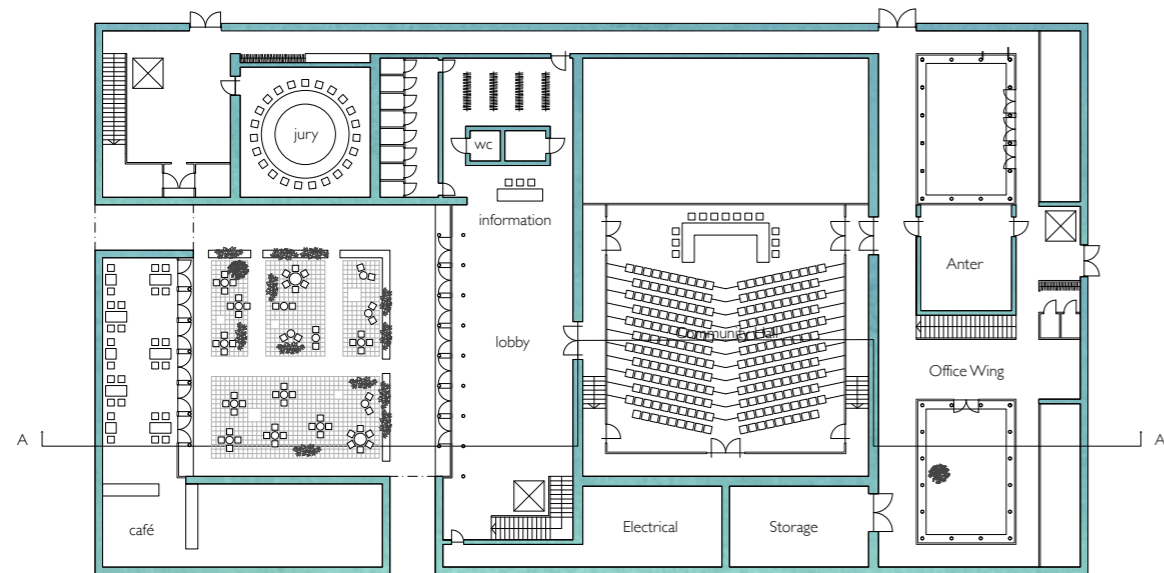
Public city plaza

The traditional city hall plaza is inverted and placed in the main atrium to invite people in. The public square acts as an extension of the lobby connected to a cafe and restaurant.

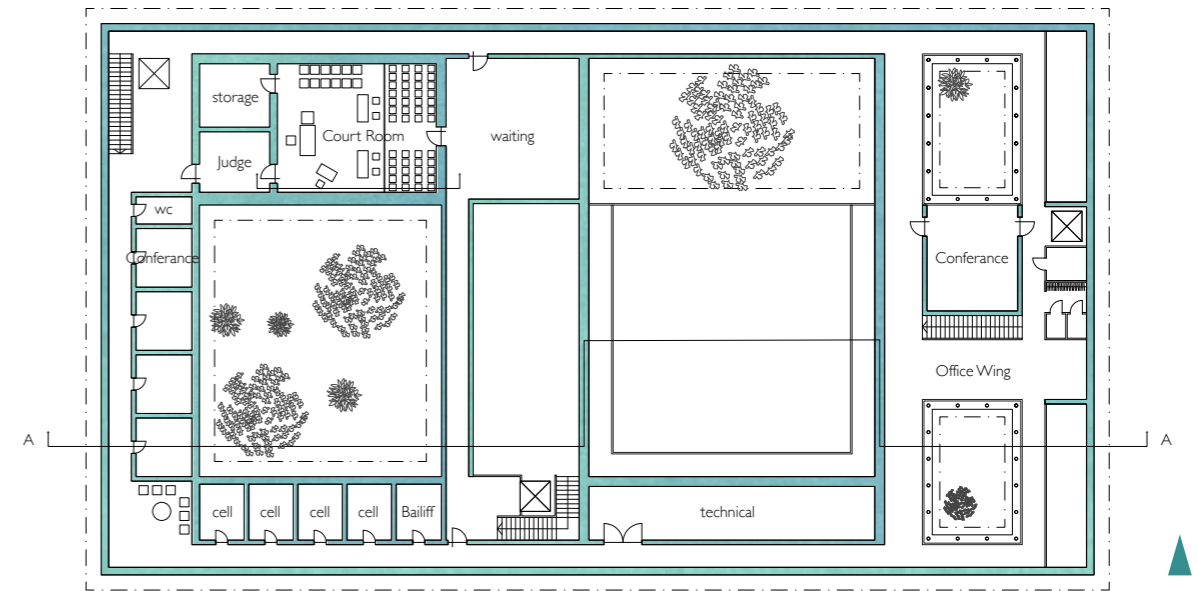


Room for democracy

The community hall is easily reached from the lobby and Garden Court which creates a floating, open space, connecting politicians to civilians. With ceremonial respect of the walk to a trial, a stair and glass corridor slows one down and prepares before entering the Court room.



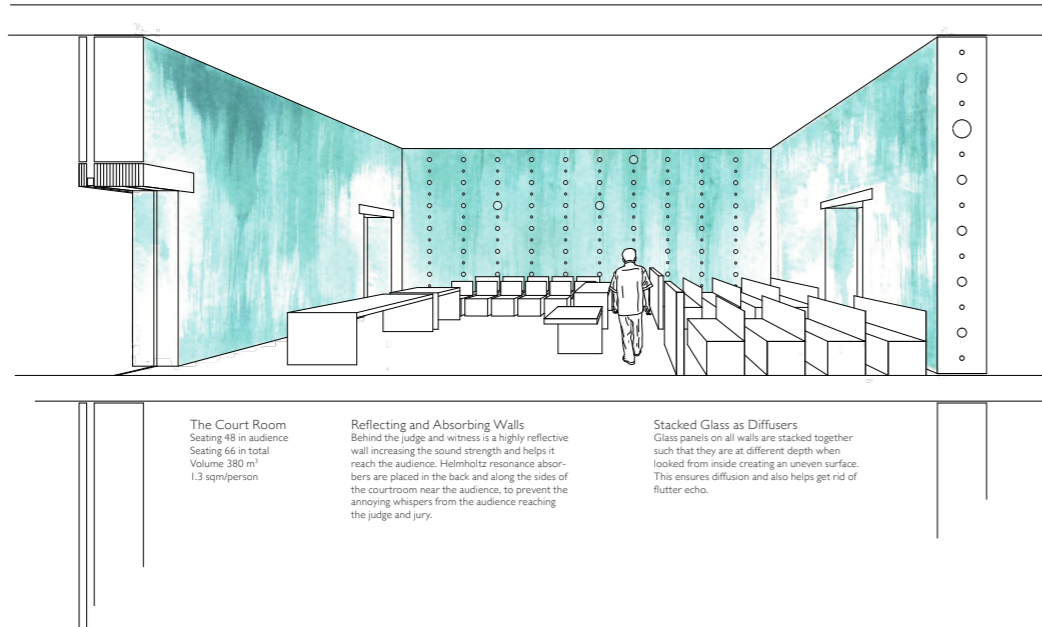
Plan 1



Plan 2

Plan 1:500

Courtroom



The Court Room
Seating 48 in audience
Seating 66 in total
Volume 380 m³
1.3 sqm/person

Reflecting and Absorbing Walls
Behind the judge and witness is a highly reflective wall increasing the sound strength and helps it reach the audience. Helmholtz resonance absorbers are placed in the back and along the sides of the courtroom near the audience, to prevent the annoying whispers from the audience reaching the judge and jury.

Stacked Glass as Diffusers
Glass panels on all walls are stacked together such that they are at different depth when looked from inside creating an uneven surface. This ensures diffusion and also helps get rid of flutter echo.

Fine demands in spoken word requires a fine instrument

The Crystal Hall is a multipurpose city hall located in Tucson, Arizona. A new venue for political meetings, small events, trials, weddings and home for many city offices. The garden plaza provides a green living room for the citizens of Tucson connecting to intimate spaces. The rooms are small and the sound precise to create good conditions for speech and music.

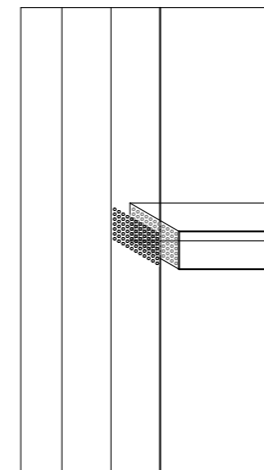
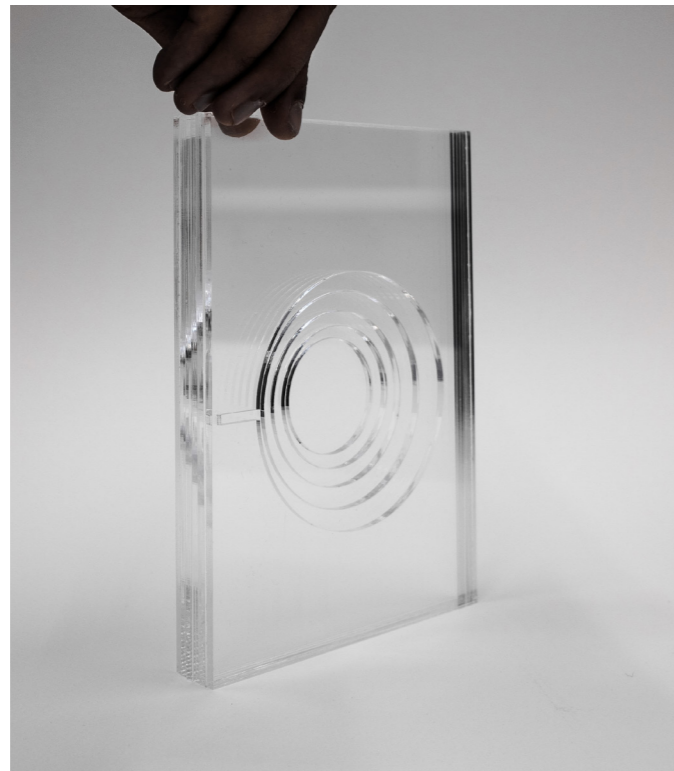
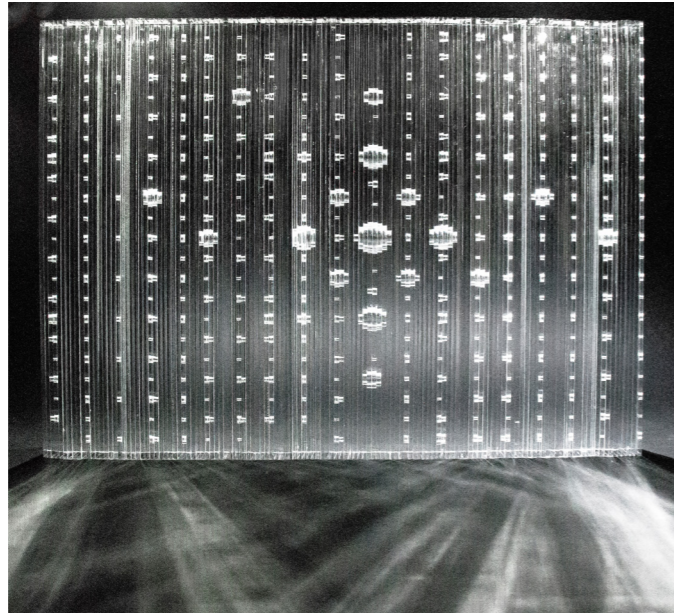
Studio environment

In a building hosting the democratic institution of justice and politics, it is important that people speak the truth. To hear all nuances of speech, the integrated Helmholtz resonators can absorb even the lowest of frequencies from 20 Hz, resulting in a studio environment.

Small volumes

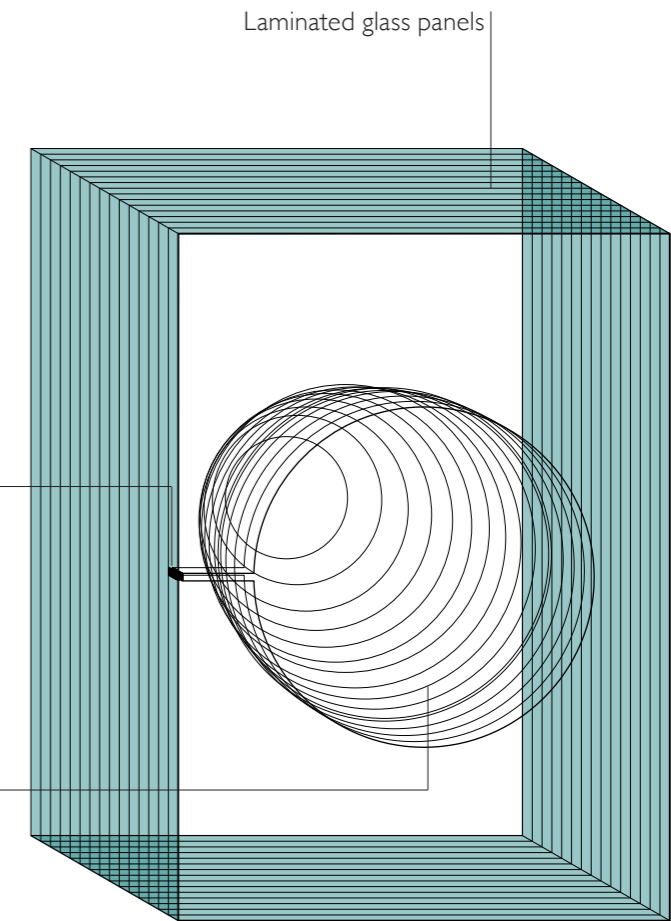
Both the community hall and the court room have approximately one square meter per person to create a sense of intimacy both spatially and acoustically. Small volumes have naturally a low reverberation time, so only a little absorption is needed. The low reverberation time helps achieve a good STI.





Micro Perforation
Detail 1:2
15x15 mm neck opening
Micro perforation for
viscous friction

Helmholtz Resonant
Absorber 20 Hz
Detail 1:10
2 mm micro-perforated glass
100 mm neck
450 mm diameter
650 mm glass panels



Transparent sound absorbers

Integrated Helmholtz resonators

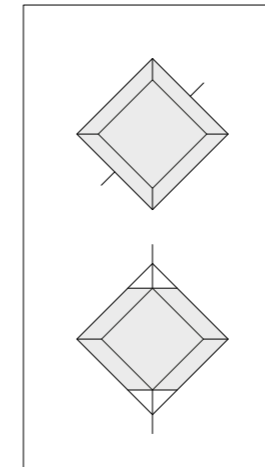
The transparent integrated Helmholtz resonators in the walls allows absorption and can be tuned to desired frequency. Micro-perforation at the end of the neck ensures absorption because of viscous friction. The Helmholtz resonant absorbers gives total control over even the lowest frequencies as low as 20 Hz. In the community hall the Helmholtz resonators are integrated in the back walls that are exposed when the crystals are open. Helmholtz resonance absorbers are placed in the back of the court room near the audience, to prevent the annoying whispers from the audience reaching the judge and jury.

Fabrication

The walls are made of laminated glass panels of the commercial and easily recycled soda lime glass. The glass walls act in compression and bending is prevented by lamination. Thanks to the thin panels, the spherical absorbing volume integrated in the walls are created by circles cut in each glass panel. In the mid panel, also acting as the neck of the Helmholtz, a thin channel is cut almost to the edge, saving a small bit for micro-perforation of holes drilled from the side. The viscous friction achieved by micro-perforation makes it possible for no other absorption material. Put together the panels create a three dimensional effect of spheres, diffusing light through the walls. The Helmholtz are visible in the lobby, in the corridor to the community hall and on the walls of the court room, having an appearance of frozen bubbles.

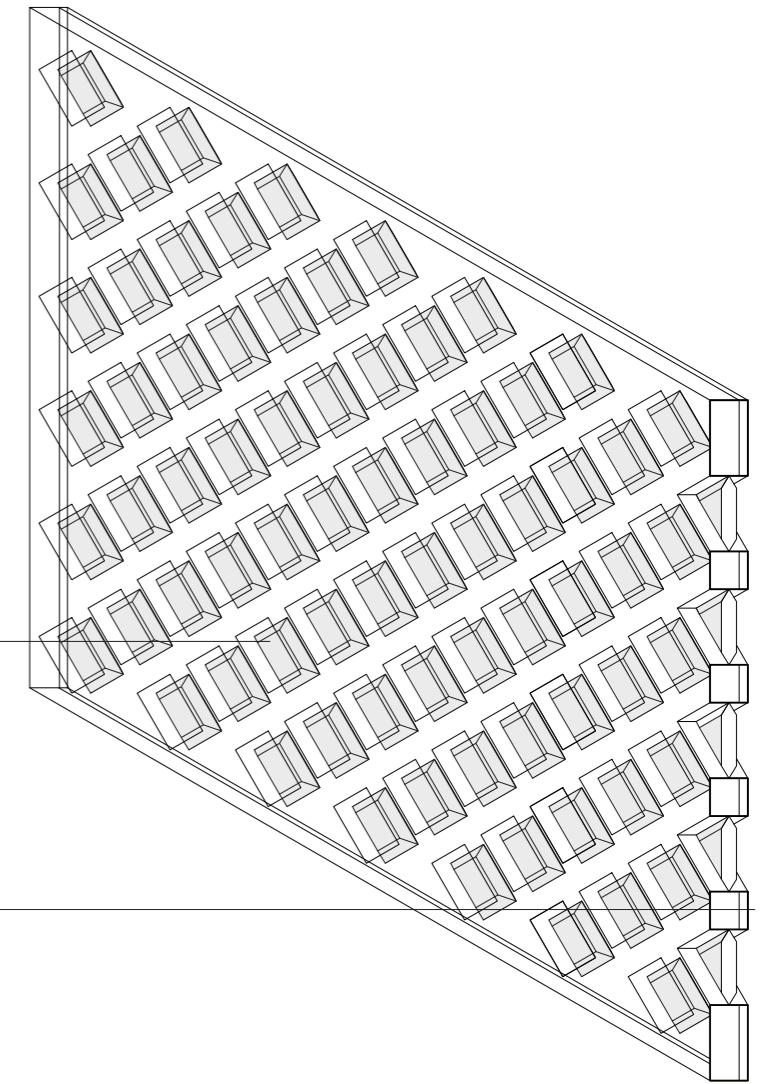


Model photographs 1. Corridor into the Community hall walking between the Helmholtz resonant absorbers and crystal wall 1:20. 2. Pattern of Helmholtz resonators appearing as frozen bubbles dispersing the light. 3. Cut section of Helmholtz. 1:10



Rotating Crystal Panels
Detail 1:10
200 mm diagonal axis
Rotating around different axis.
The surface is frosted and the cut clear creating an dispersing light effect.

High Frequencies Absorption
Detail 1:20
100 mm concrete
high frequency absorber
Absorbing material placed at the back of the crystal wall ensures the absorption of mid to high frequencies.



Variable acoustic Crystal wall

Dispersing light and sound

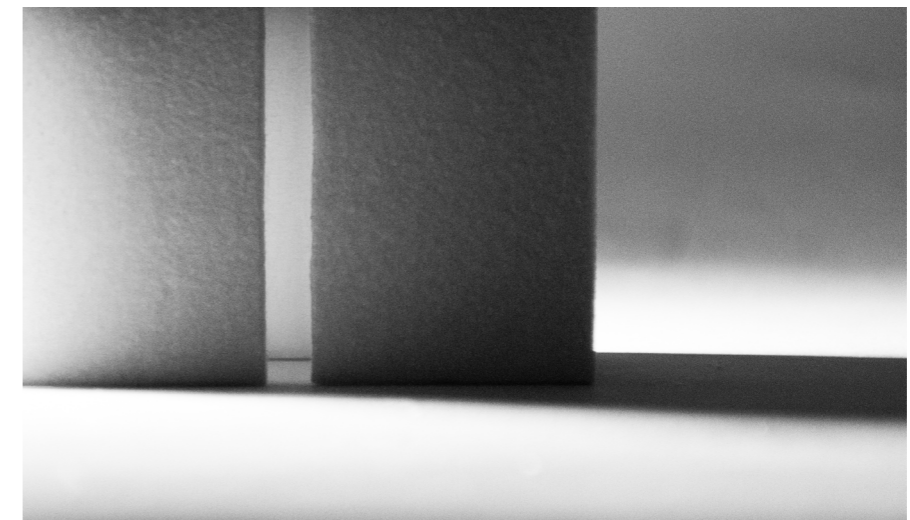
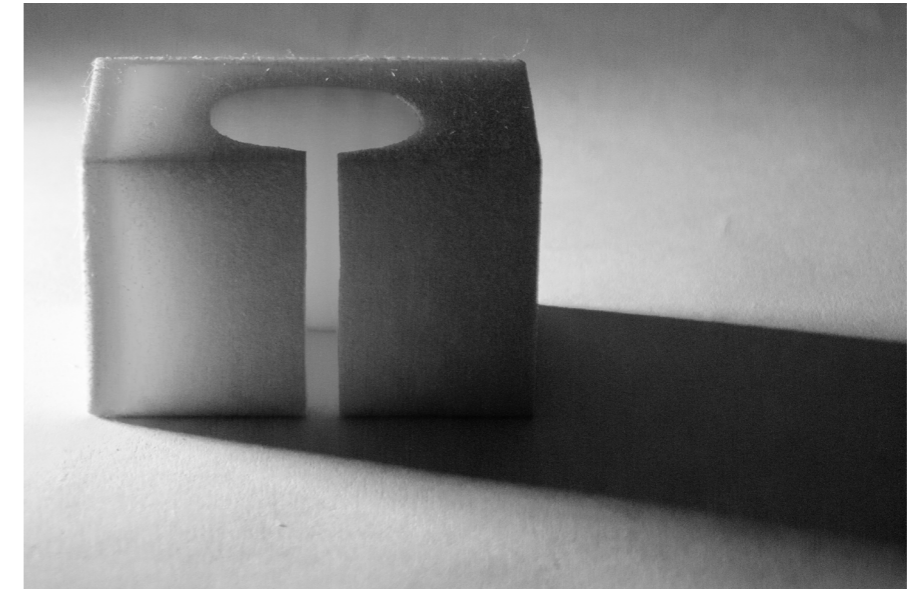
The crystal wall allows variable acoustics and natural lighting in the community hall. Fully opened they expose the hall to high and low frequency absorbers behind, and when closed they reflect the incident sound resulting in higher reverberation time. The crystals also scatter and diffuse the sound in different directions depending on their orientation and help to get rid of flutter echo between parallel walls. Opening up to low and high frequency absorbers, a flat reverberation time for music and speech is achieved. The crystal walls are located in the back and along the sides of the room letting light through while the focus of the audience is directed towards the stage. The big Jacaranda tree in the atrium behind create a calm and centered view.

Music

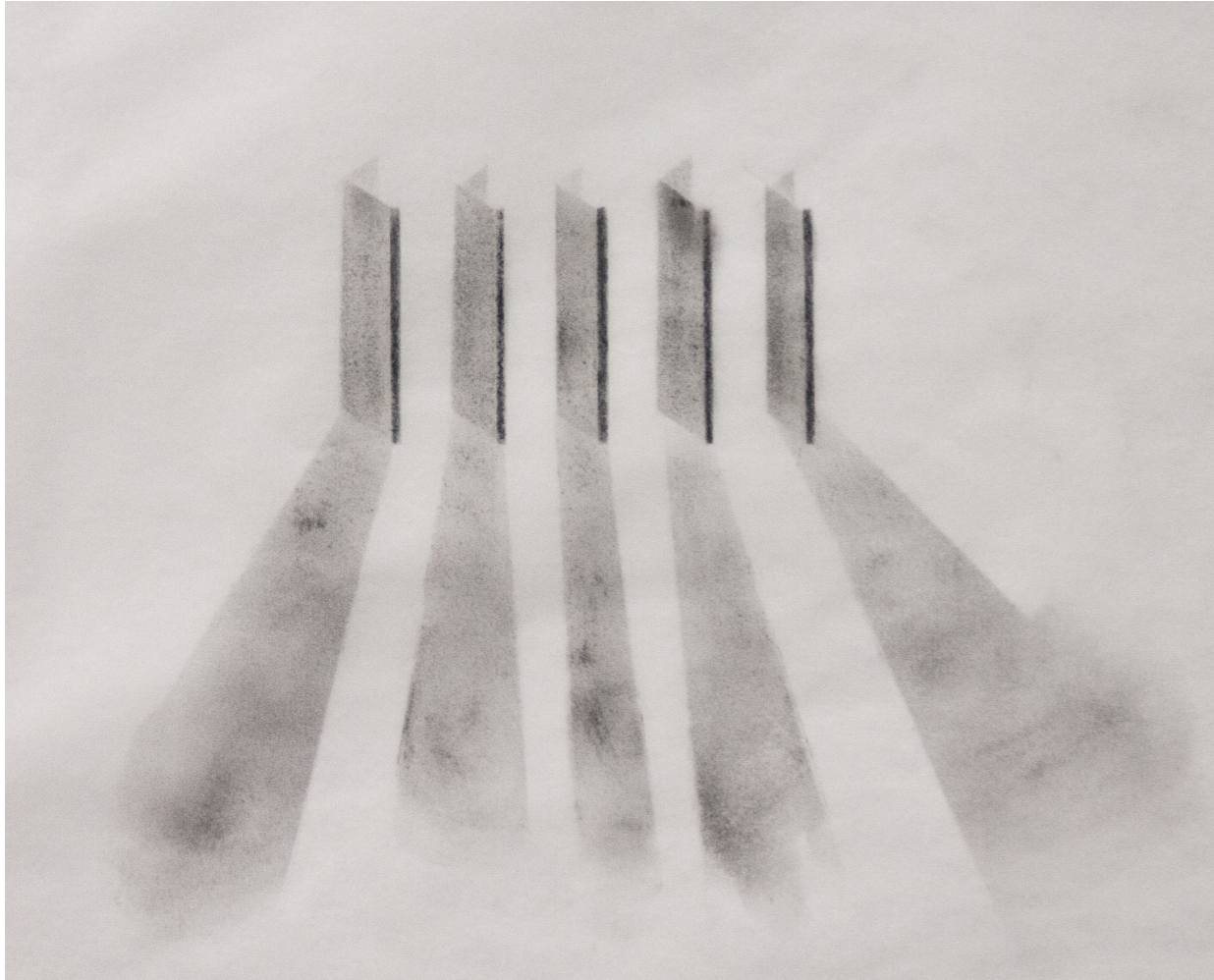
Most of the crystals are closed to reflect sound and elongate the reverberation time and to get the required clarity for music between -2 and +2 dB.

Speech

Most crystals are open to the absorbing corridor that creates a flat reverberation and good STI value. The rise in reverberation time due to slight increase of volume is dealt with by having sufficient absorption so that the net reduction in reverberation time meets the requirements for speech.



Model photographs, early phase. Experimenting with an inverted plaza and a glowing inside.



Sketches of early study models, tape and graphite.