

# SHARDS OPERA HOUSE

As my bachelor thesis we entered a competition held by The Acoustical Society of America's Technical Committee. A competition intended to encourage students to express their knowledge of architectural acoustics and noise control in the design of an opera in which acoustical considerations were of significant importance.

During the design we made continuously acoustical calculations in collaboration with an acoustical master student. The results affected the design and vice-versa.

COURSE	Bachelor's degree project
YEAR	Spring 2013
EXTENT	15 hp
EXAMINER	Morten Lundh, Mendel Kleiner
COLLABORATORS	Arvid Söderholm, Tor Möller
SITE	Westmount, Montreal, Canada
TYPE	Public
RELATED ENGINEERING COURSE	Climate Systems
TOOLS	AutoCAD, Rhino, Grasshopper, V-Ray, Adobe CS, SketchUp, CATT Acoustics

# Introduction

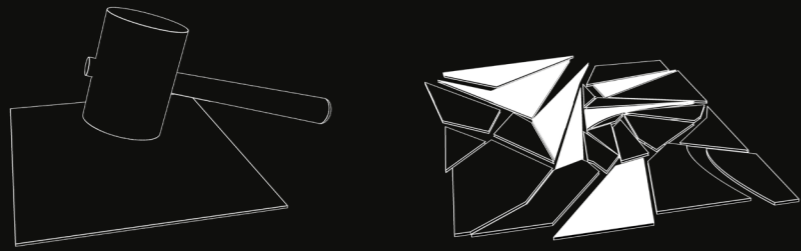
Acting as an urban sculpture and a new landmark for the city of Montréal, the opera offers to both citizens and tourists a place for exploration, music, events and activities. The distinctive design along with its magnificent height separates the building from its surroundings and engages the spectator to explore its various heights and revealing geometric meetings.





## CONCEPT

The conceptual idea is inspired by the shape and natural beauty of broken ice shards. This idea was taken into reality by picking out the shards created from an impact to a block of ice and then bent and rotated in different ways to form the walls, windows and roof of the building.



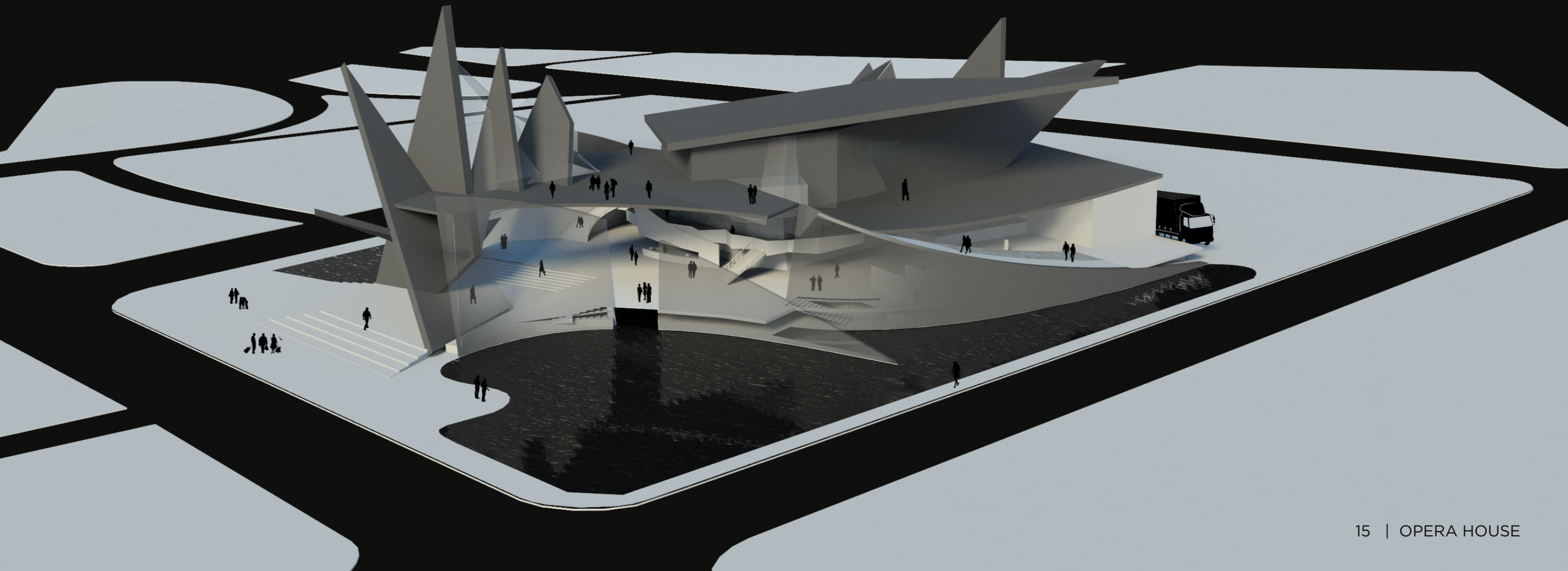
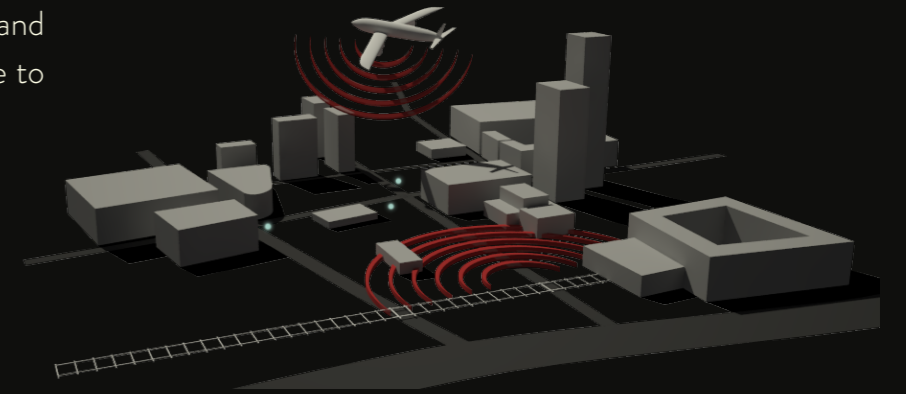
*A block of ice is smahed into small shards with a hammer.*

*Suitable pieces are selected to form the shape of the exterior and giving the building it's organic shape*

## SITE

The opera has a welcoming approach with the main entrance and all attractions facing the open areas to the northern and estern sides of the site.

The site poses a great challenge regarding noise transmission with multiple external sources such as aircrafts, railroad and traffic. The tesson is accordingly planned with great care to meet the strict noise level requirements.



## ACCESS & ACTIVITIES

As a visitor of the opera you are offered a number of activities and rooms to explore. Access, openings and views are orientated towards the eastern site where the water lies as a mirror in front of the opera and the green park on the opposite side.



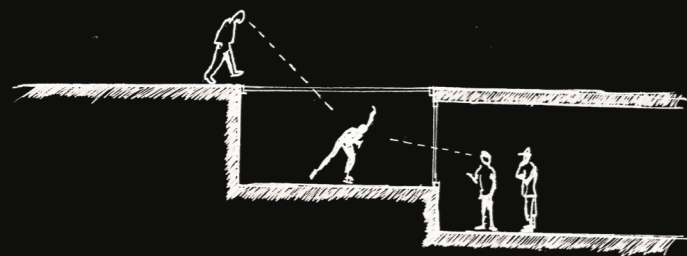
### Café

A relaxing area with view over the water and Montreals skyline. Offers both indoor and outdoor seating. On the second floor of the café you have the VIP lounge.



### Water and Ice Skating

Water surrounds the building on both sides and is connected through a passage underneath the foyer which is visible from both the foyer and the exhibition area. During winter the water pools freezes and functions as a ice skating rink. People can then ice skate between both sides.



*Ice passage underneath foyer and beside exhibition area*



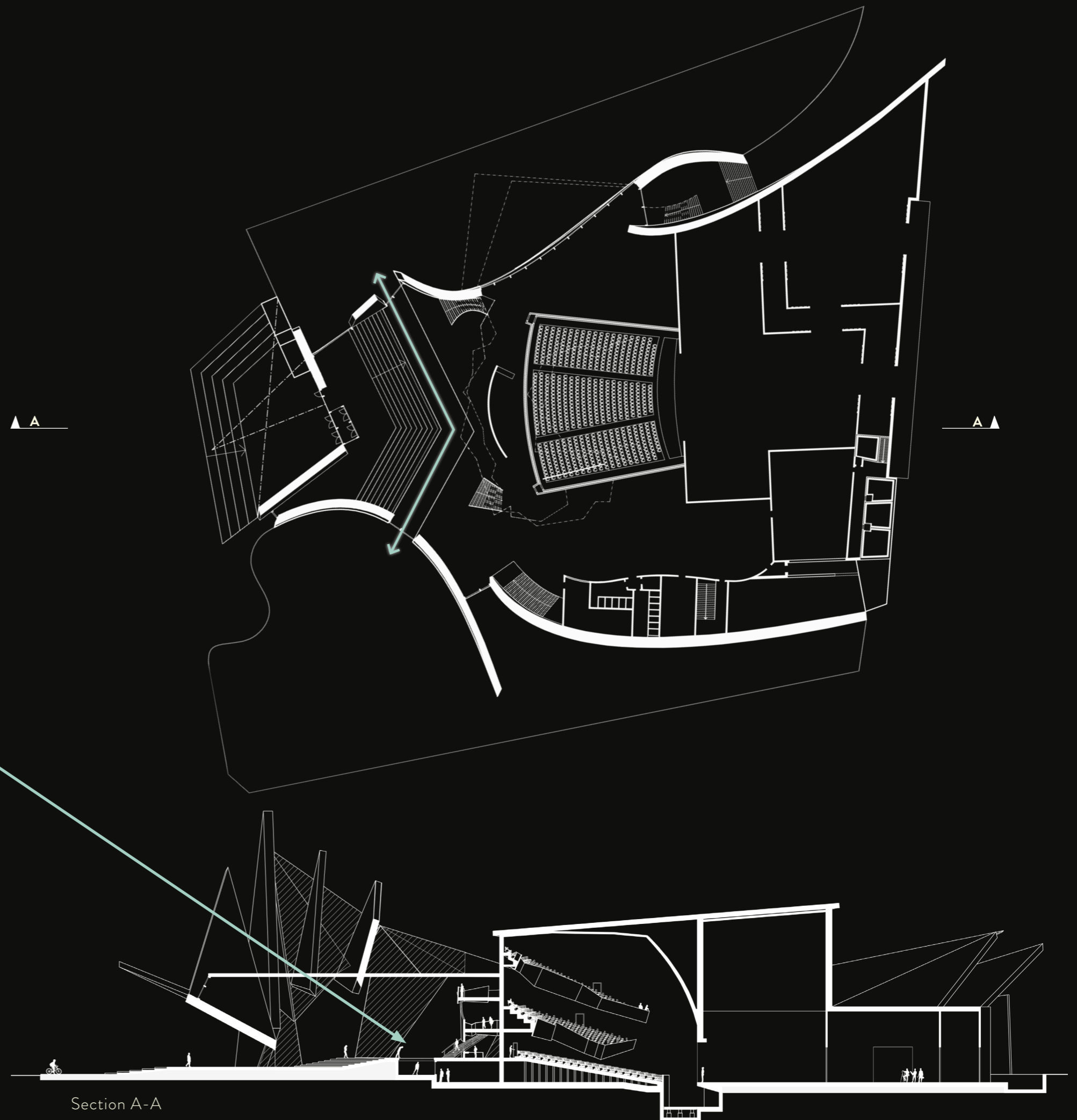
### Roof

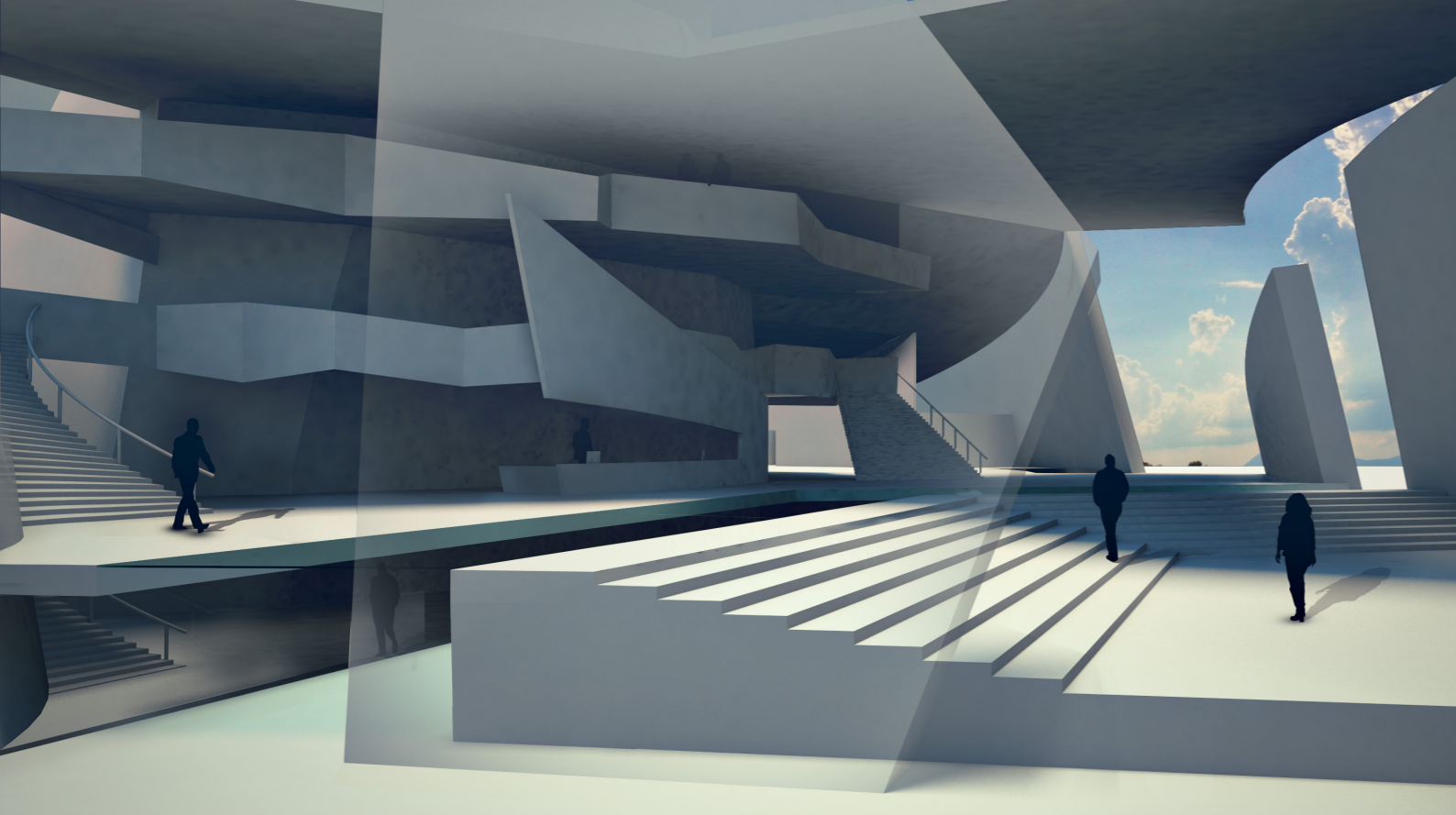
Visitors of the opera can reach the roof terrace from several places and enjoy a magnificent view over the city and at the same time getting some fresh air during breaks between acts.



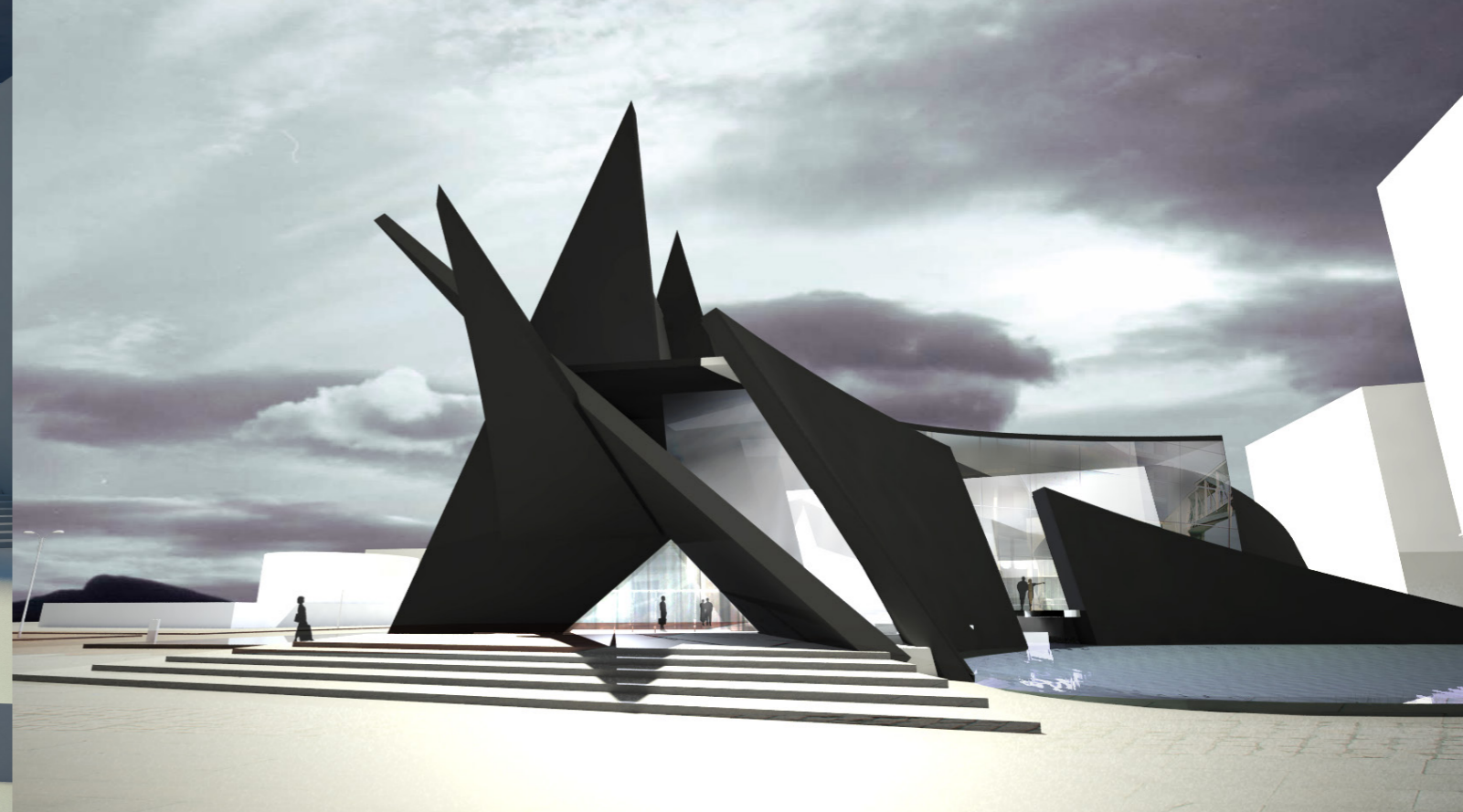
### Exhibition

The exhibition area on the bottom floor is reached from both sides of the foyer. It's in direct contact with the ice passage and is lit up by skylight penetrating all the way from the roof of the foyer.

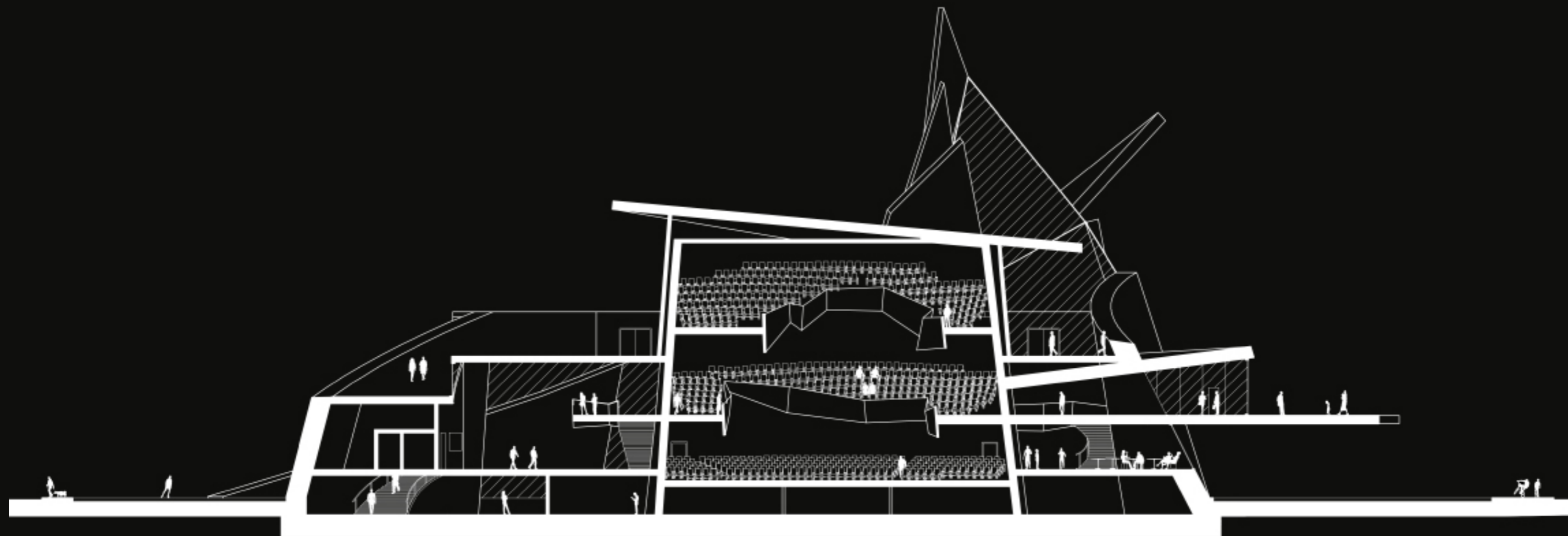




*Exterior view of foyer and exhibition area*



*Exterior view of entrance*



Section B-B

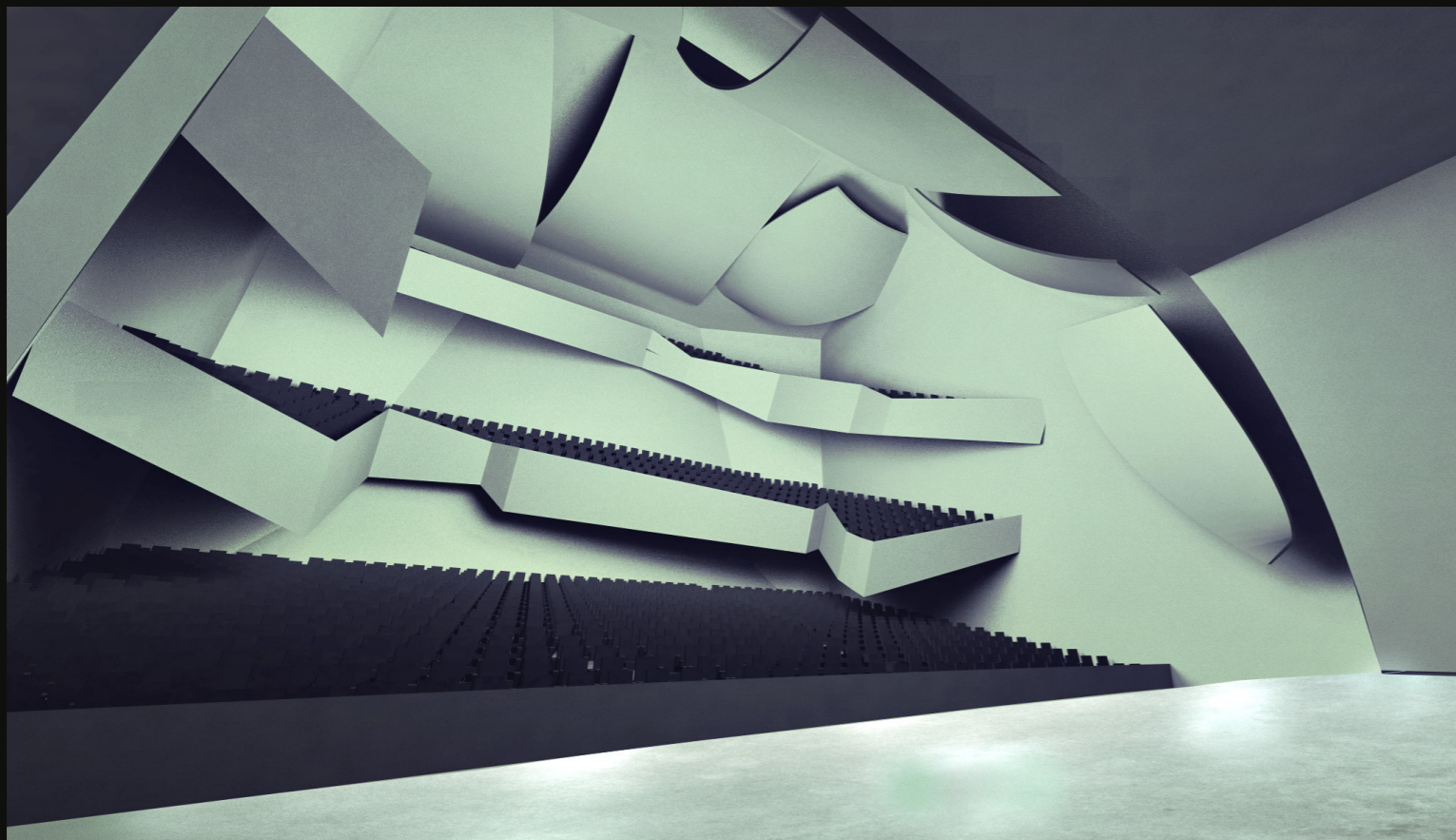
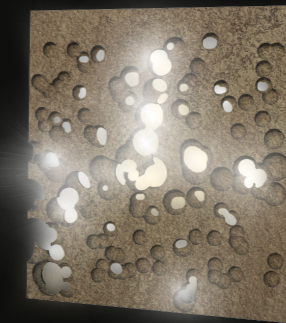


## AUDITORIUM

Entering the performance hall the whole volume shimmers in the light shining through perforated Butong, forming the balcony fronts and wall sections. Wooden panels on the side walls bring warmth to the room and offer a tasteful contrast to the ridged stone partitions and the bright ceiling reflectors.

The entire auditorium is designed as an isolated inner shell to terminate noise from the lobby as well as structure borne vibrations from the roof and outer balconies. A double door sound lock system with highly absorptive walls and ceiling allows visitors and personnel to move in and out during performances.

The balcony fronts consist of Butong, a perforated concrete with a warm, shimmering glow when lit from behind. By controlling the size and depth of the perforations the Butong panels can form both broadband diffusers and low end absorbers.



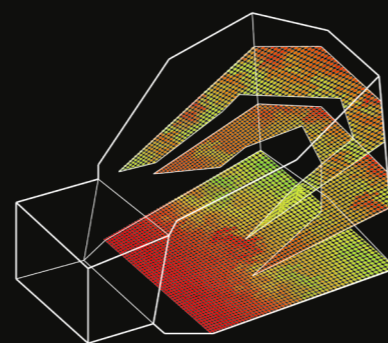
 **1200**  
seatings

 **1.5**  
seconds

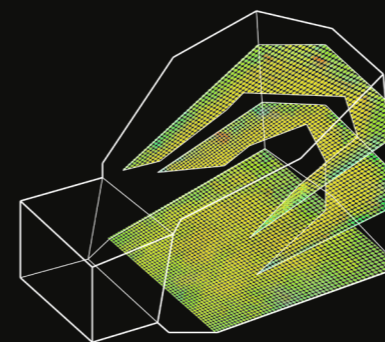
 **MULTIPURPOSE**  
use

## ACUSTICS

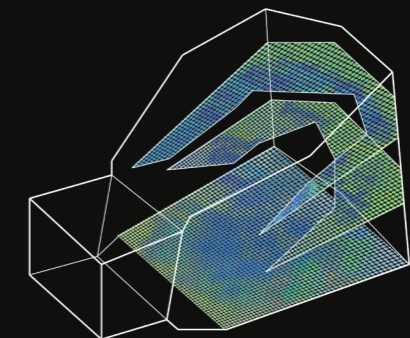
Fully crowded the performance hall offers a reverberation time of 1.5 s and clarity in the -2 dB range, suitable for music and opera performances. The sidewalls and balconies are shaped to provide the early reflection pattern necessary to induce a strong sense of envelopment. Variable acoustics allow the reverberation time to be lowered and the clarity to be increased, without compromising the warmth of the sound.



Sound pressure levels are evenly distributed throughout the auditorium, the strength ranges in the 3-5 dB region.



The reverberation time shows only minor deviations vouching for a good balance in material properties and balcony dimensions. Reverberation time (T30) around 1,5 s



A consistent clarity (C80) throughout the auditorium means suitable weighting in surface properties as far as balance between early reflections, scattering and absorption.

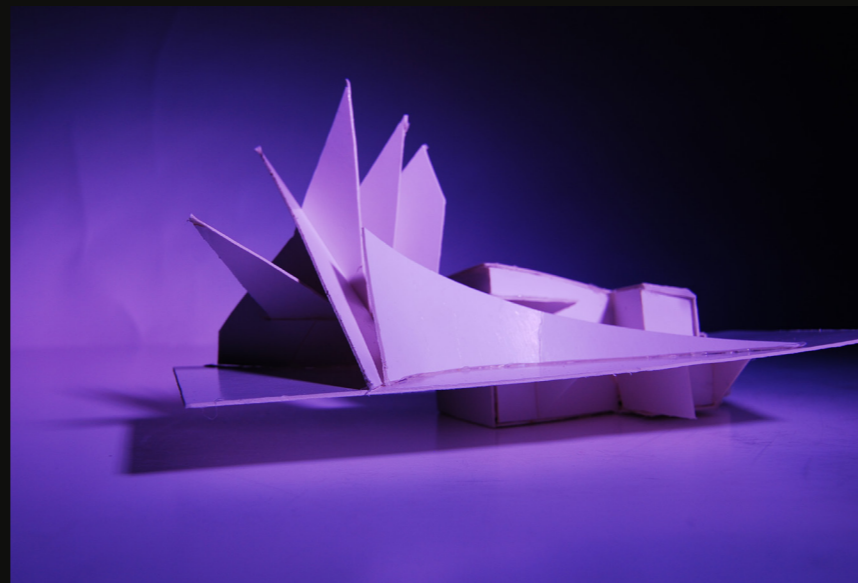
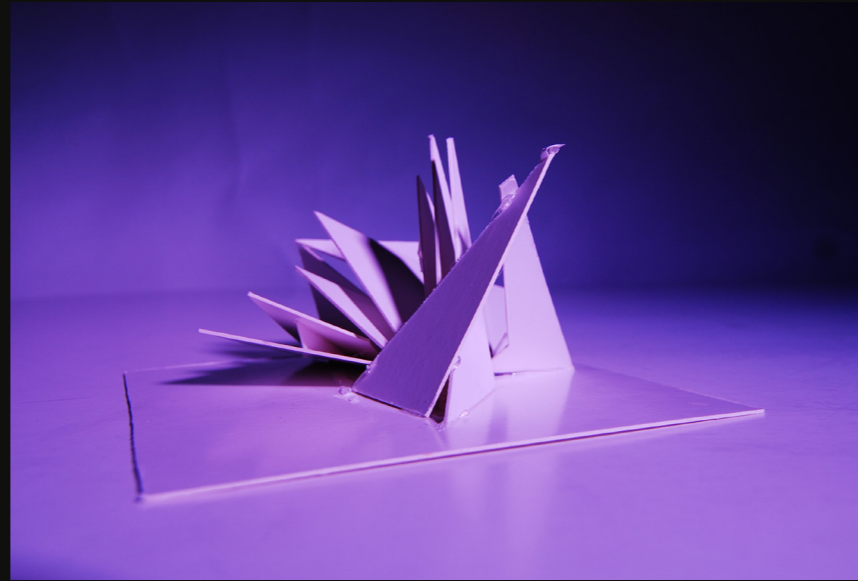
## IDEA & PROCESS

The process consisted of several iterations where we started to build multiple small concept models of cardboard and had discussions in small groups during a seminar criticism. We then selected the concept we liked best and made more, and more detailed models in bigger scales. In the project's initial phase, we also had some experimental acoustic exercises and lectures with our acoustics professor Mendel to get an overview of the subject.

The conceptual idea is inspired by the shape and natural beauty of broken ice shards. This idea was taken into reality by picking out the shards created from an impact to a block of ice and then bent and rotated in different ways to form the walls, windows and roof of the building. The shapes do not only inspire the exterior of the opera but also the balcony fronts in the auditorium and in the foyer.



## CONCEPT MODELS







## **Uppgiftsbeskrivning**

Uppgiften byggde på att presentera ett förslag till ett nytt operahus i Montreal, Kanada där vi skulle formge en byggnad utefter de krav angivna av Acoustical Society of America. Byggnaden skulle fungera både som offentlig och som studentbyggnad.

## **Reflektion metod & process**

Vi startade hela processen med att punkta upp egenskaper och funktioner vi ville att vår byggnad skulle innehålla. Därefter var det dags för analys av platsen där vi tog hänsyn till väderstäck, tillgänglighet, trafik, siktlinjer, grönområden, kringliggande byggnader och eventuella bullerpåverkningar. När vi väl bestämt oss för hur byggnaden skulle orienteras och fördelas började vi skissa på exteriören genom modellbygge samtidigt som vi började spåna på fördelning av rum och ytor på planlösningen.

Då vi hade en ganska komplex inspirationsform så var modellbyggande i papp utan tvekan det bästa tillvägagångssättet då man enkelt kunde studera formen ur alla vinklar. Sakta men säkert började byggnaden ta form och vi övervägde konstant fördelar och nackdelar mellan olika uttryck/varianter.

När vi väl bestämt oss för en tilltalande form började vi jobba på att få vår preliminära planlösning att passa in i byggnaden. Efter mycket ömsesidigt pusslande mellan plan och exteriör fick vi tillslut ihop en väl fungerande lösning. Därefter följde en hel del finjusteringar m.a.p. akustik och tillgänglighet.

Summering: är väldigt nöjd med vårt tillvägagångssätt och arbetsprocess, då det i största allmänhet flöt på väldigt bra genom projektet. Det var sällan vi fastnade och det känns som att vi hade ömsesidig uppfattning om vad vi jobbade mot.

## **Reflektion av resultatet**

Kandidatarbetet var ett väldigt intressant och utmanande projekt ur många vinklar. Det gav en möjlighet att sätta sig in i ett helt nya områden inom arkitektur där man ställdes inför många problem att tackla, samtidigt som man fick väldigt fria händer att skapa en uttrycksfull och ikonsk byggnad.

Arbetsmässigt flöt det på bra och samarbetet mellan oss i gruppen fungerade väl. Vi bestämde oss tidigt för ett koncept och höll fast vid det, ett koncept som jag personligen tyckte hade en komplex men samtidigt stark karaktär och därmed öppnade upp för möjligheten att skapa något unikt.

I slutändan tycker jag att vi lyckades skapa en uttrycksfull byggnad med många kvalitéer i form av upplevelser/aktiviteter och användning. Mest nöjd är jag med entrépartiet och byggnadens formspråk i NV-N riktning.

Summering: Hade vi haft mer tid så hade jag velat jobba vidare på foajén och rörelsen mellan de olika delarna av byggnaden i hopp om att skapa en starkare upplevelse invändigt. Det känns som att vi lade mest vikt vid design och aktiviteter/upplevelser, vilket gjorde att de akustiska kvalitéerna ibland inte prioriterades. Rum så som green room och rehearsal room hamnade i bakgrunden och hade gott och väl kunnat arbetas mer med.