BUBBLES

ACEX15	Kandidatarbete i Arkitektur och Teknik
Lärare	Morten Lund, Peter Christensson
Verktyg	Fysisk modell, Rhino, Illustrator, Photoshop
År	2019 Åk.3

In many previous projects, the goal has been to ask a question and ones that question is answered, the project is finished. This project takes another point of view. The goal was to find as many questions as possible, presenting a potential answer whilst continuing on to the next question. However, it all started with the first and hardest question, what to do?

The task

Many years the student competition hosted by the Acoustical Society of America has been used as the candidate project of Architecture and Technology, however this year the competition was an utterly boring one. Therefore, the project started with defining what to do. Me and my companion Tobias therefor wrote a simple list, titled Vad vore skoj? (What would be fun?). The list included many things, but essentially they stated that we wanted to be experimental, play with a variety of parameters such as light, expectations and behaviour, keep a concept throughout the design and to go all the way. We also wanted some kind of restrictions regarding the location and space, to be in an urban context and the building were to host at least one or more concert halls. This then resulted in the decision to use the skyscraper defined in the competition, but instead of renovating an office floor, we were to fit a concert hall into it.

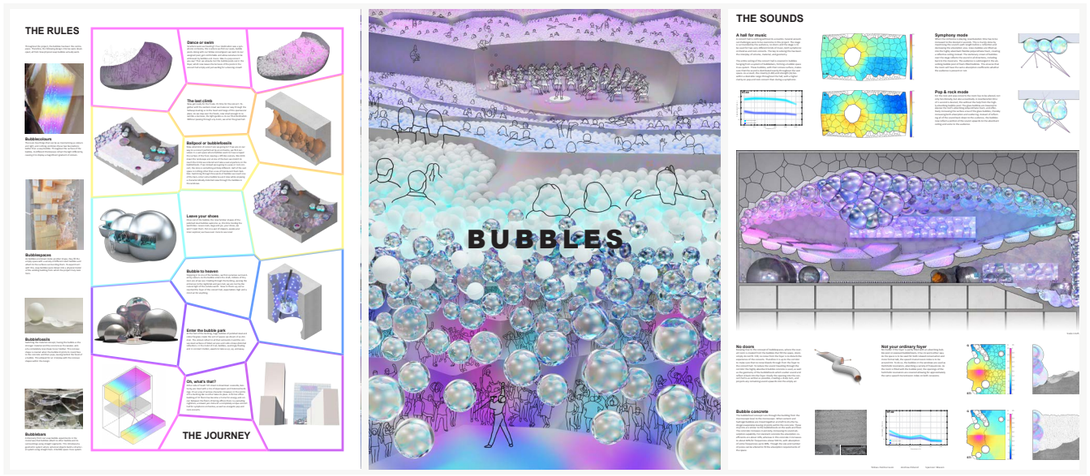
The process

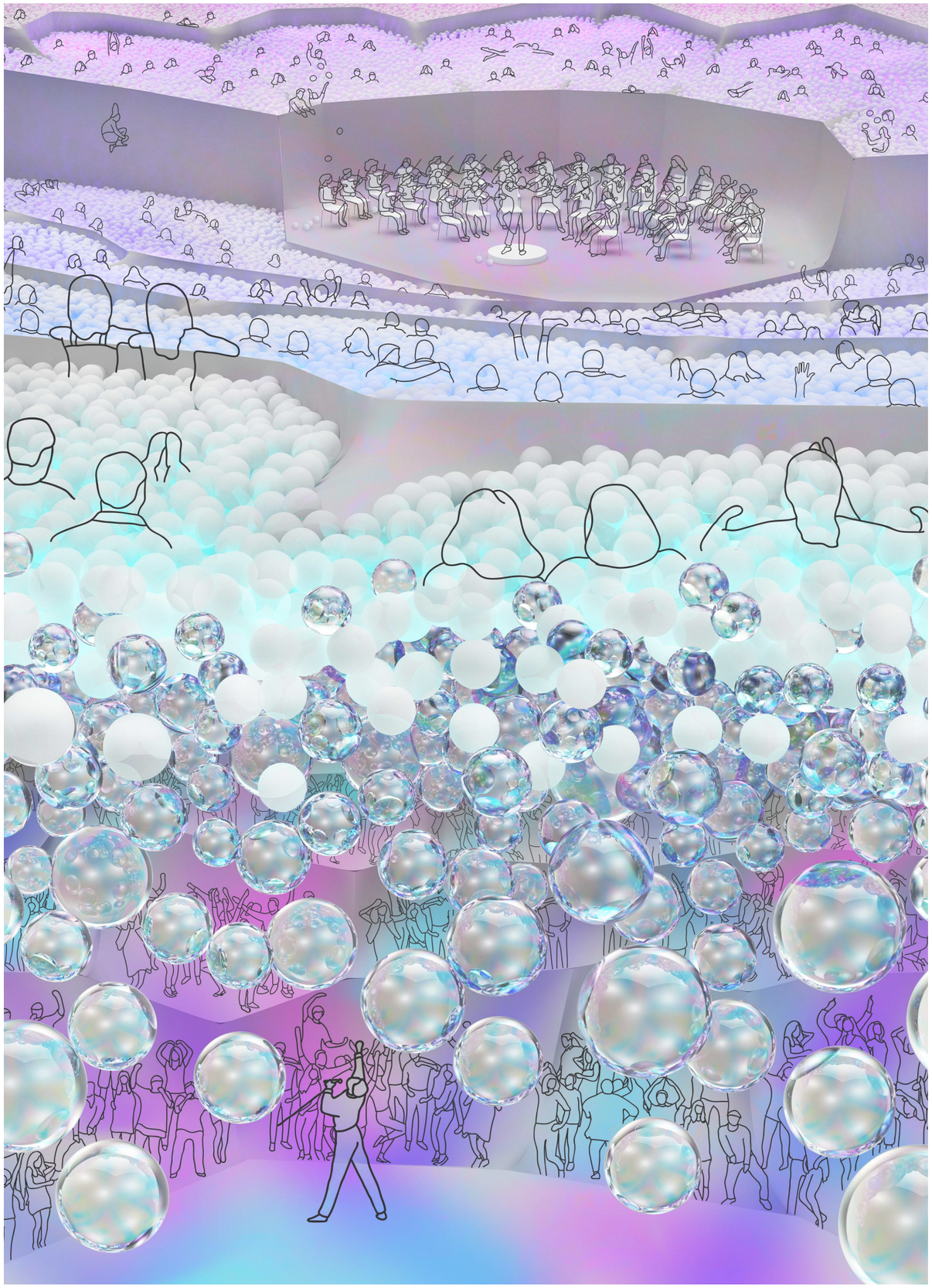
With the direction of the task set, we started searching for concepts. We allowed ourselves to be inspired by anything, coffee makers, the human body, origami, rock carving and soap bubbles. We decided on the bubbles. There was something so playful but yet sophisticated about the bubble that drove us to explore it further, and out findings only made us love it more. Just by blowing soap bubbles in a container (PET bottle) we could see layers of transparency resulting from the sizes and the beauty in the variety of shapes. Continuing on, we made a model of the skyscraper built of modulus of foam cubes inside a rectangular plastic container. We then removed modulus to create open spaces in the structure, in which we blew bubbles. This time it was the bubbles ability to fill space, to attach to its surroundings and, most importantly, their colours, that fascinated us.

In order to push the project forward whilst making sure that we were understanding each other, me and Tobias adopted the idea of sketch-races. With starting point in words and conversations we sketched freely for a limited period of time (40min) and then discussed again. This was a quick way of finding any misunderstandings but also a great way to expand our ideas. We used the sketch races for all parts of the building, the entrance park, the elevator, the foyer, the acoustics, the formations of the ball pools, well everything. It was also a great tool for communicating our ides to our acoursical advisor, Spencer, as communicating architecture by words is often harder han though pictures, especially if one is not used to it.

Learnings from the project

This is by far the project in which I've personally had the most fun, and it showes. My years of studying finally made me confident enough to go for the crazy, to embrace the chindishenss and to think one step further all the time. The project is therefore a result of loads of questions asked and answered. It is a dearing architectural peice in it's way to neglect compromizes and cast aside the though of what's "impossible". It aims to present an alternative to the conventional and the maximization of a concept. Bringing together two contradicting factors, childish and sophisticated, it is, in my personal oppinion, the perfect finale of my baccelor.



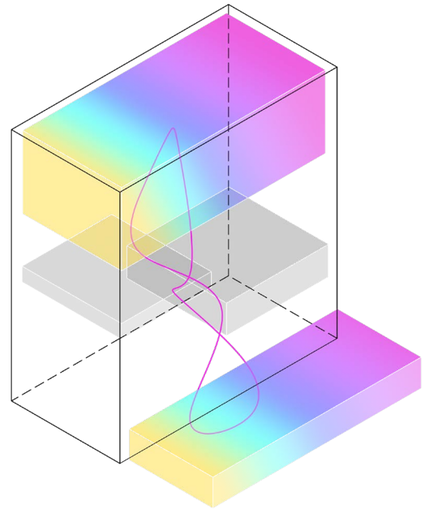


BUBBLES

At the top of a skyscraper, a music hall is placed, however the journey there is just as important as the hall itself. Approacing the building, the visitor is to be encouraged to expore and let the inner child awake, this thanks to the mesmerizing bubbles.

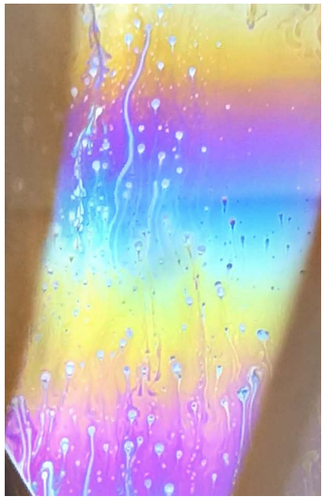
The bubble were never to be a decoration, it is the centerpiece of the design. Therefore, many conventional areas of a building became subjected to questioning. Such as elevators, doors and chares. With the translucency of clusters of small bubbles, like bathing foam, the idea of using a ball pool for seating came to mind. After a field trip to a local children's playhouse, testing the comfort, noise and movability of a ball-pool it was decided. As crazy as it seemed, it became a solution to several problems as well as a huge help in unlocking our mind. Because once you decide to have your audience submerged in a bubble pool, nothing feels out of bounds any longer.

The bubble pool allowed for the idea of a variable hall, by emptying the pits, a terrace like dance floor emerge. So the idea of having a hall which could be altered depending on the music grew stronger. This naturally lead to the challenge of variable acoustics.



Bubblespaces

As bubbles are blown inside another shape, they fill the empty space with a variety of different sized bubbles and attach to the surfaces surrounding them. To experiment with this, soap bubbles were blown into a physical model of the existing building from which the project truly took form.



Bubblecolours

There are few things that can be as mesmerizing as colours and light, and nothing combines these two fascinations better than a soap bubble. Throughout the surface of the bubble, its different thicknesses refract the light differently, causing it to display a magnificent gradient of colours.

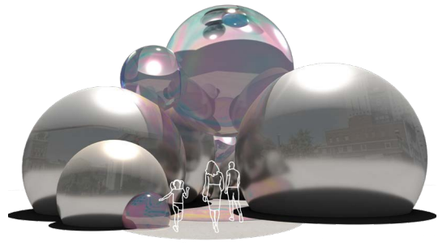
Bubblefossils

Switching the material concept, having the bubble as the stronger material and the concrete as the weaker, added a new shape to our toolbar. The convex chape of the bubble leaves a convex chape in the concrete, a bubble fossil.

Bubblebars

A discovery from our soap bubble experiments in the model was that bubbles attach to oneanother and its surroundings using straight segments. This introduced a geometric system where spherical objects build a structural system using straight bars. A bubble space truss system.

THE JOURNEY

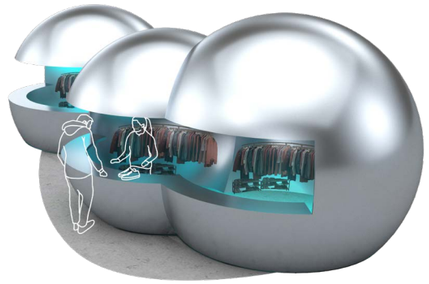


Oh, what's that?

Either side of South 5th street in downtown Louisville, Kentucky, are lined with a mix of skyscrapers and historical buildings. It's an area of serious character. However, in the centre of it a building like no other takes its place. A former office building of 15 floors has become a home for energy and colour. Between the floors of boring offices there is a pulsating nightclub, a relaxed jazz club and a completely unique concert hall for symphonic orchestras, as well as energetic pop and rock concerts.

Enter the bubble park

At the foot of the building, huge bubbles of polished steel and colourful glass create the sort of spaces we dream of as children. The colours reflect in all that surrounds it and the convex steel surfaces of ticket services and cafes shows distorted reflections. In the midst of it all, bubbles, seemingly floating and in constant motion, awaits to take us up, up, and away.

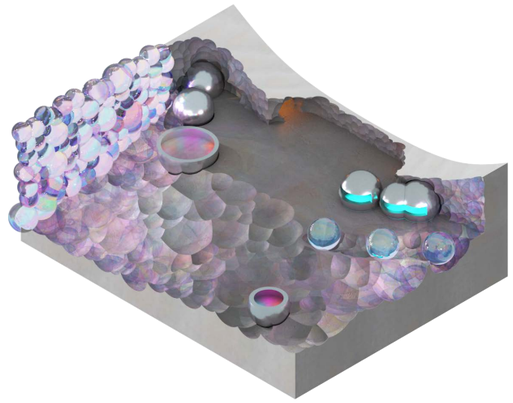


Bubble to heaven

Stepping in to one of the bubbles, we find ourselves surrounded by colours. As the bubble enters the shaft, millions of tiny stars are all we see. Floating through the building, passing the entrances to the nightclub and jazz club, we are met by the natural light of the outside world. Now 11 floors up, we've reached the foyer of the concert hall, expectations high and a mind set for anything.

Leave your shoes

Once out of the bubble, the now familiar shapes of the polished steel bubbles welcome us, this time hosting the wardrobes. Leave coats, bags and yes, your shoes, we won't need them. Put on a pair of slippers, awake your inner explorer, we have even more to see now!



Ballpool or bubblefossils

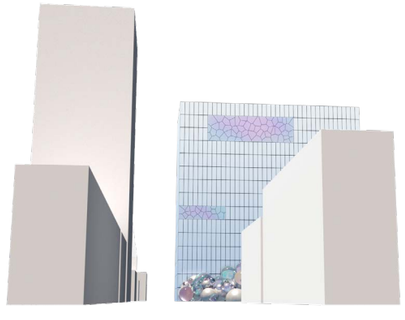
Now, what kind of concert are we going to? If our concert is performed by an orchestra, we find ourselves in a space where bubbles have scraped the surface of the floor, leaving a cliff-like scenery. We climb down the landscape and at one of the bars we stretch to reach our drinks and take a seat on the bubblefossils.
If we instead were going to a pop concert, the story is something entirely different. Half of the vast space is nothing other than a sea of translucent foam bubbles. Swimming through thousands of bubbles we reach one of the bars, order some bubble tea and relax while enjoying a characteristically distorted view through the bubbles in the windows.

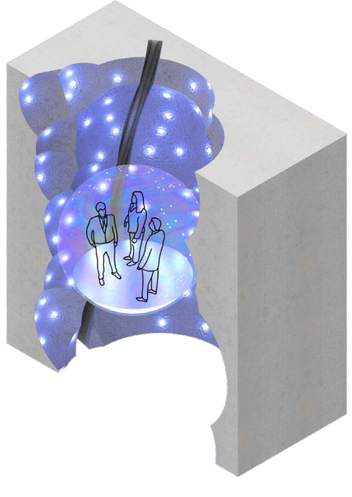
The last climb

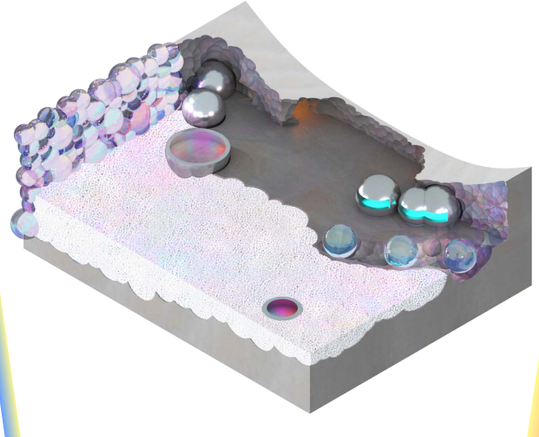
Now, get ready for the finale, it's time for the concert. Together with the excited crowd we make our way through the hallways leading us to the heart and lungs of this spectacular place.
As we step over the fossils, now small enough to resemble a staircase, the light guides us to our final destination. Without passing through any doors, we enter the great hall.

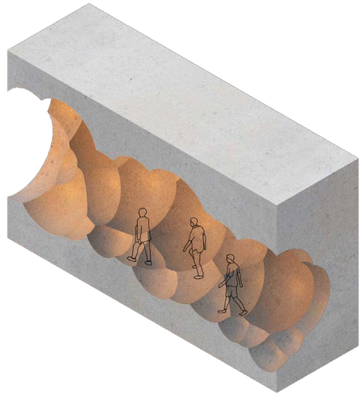
Dance or swim

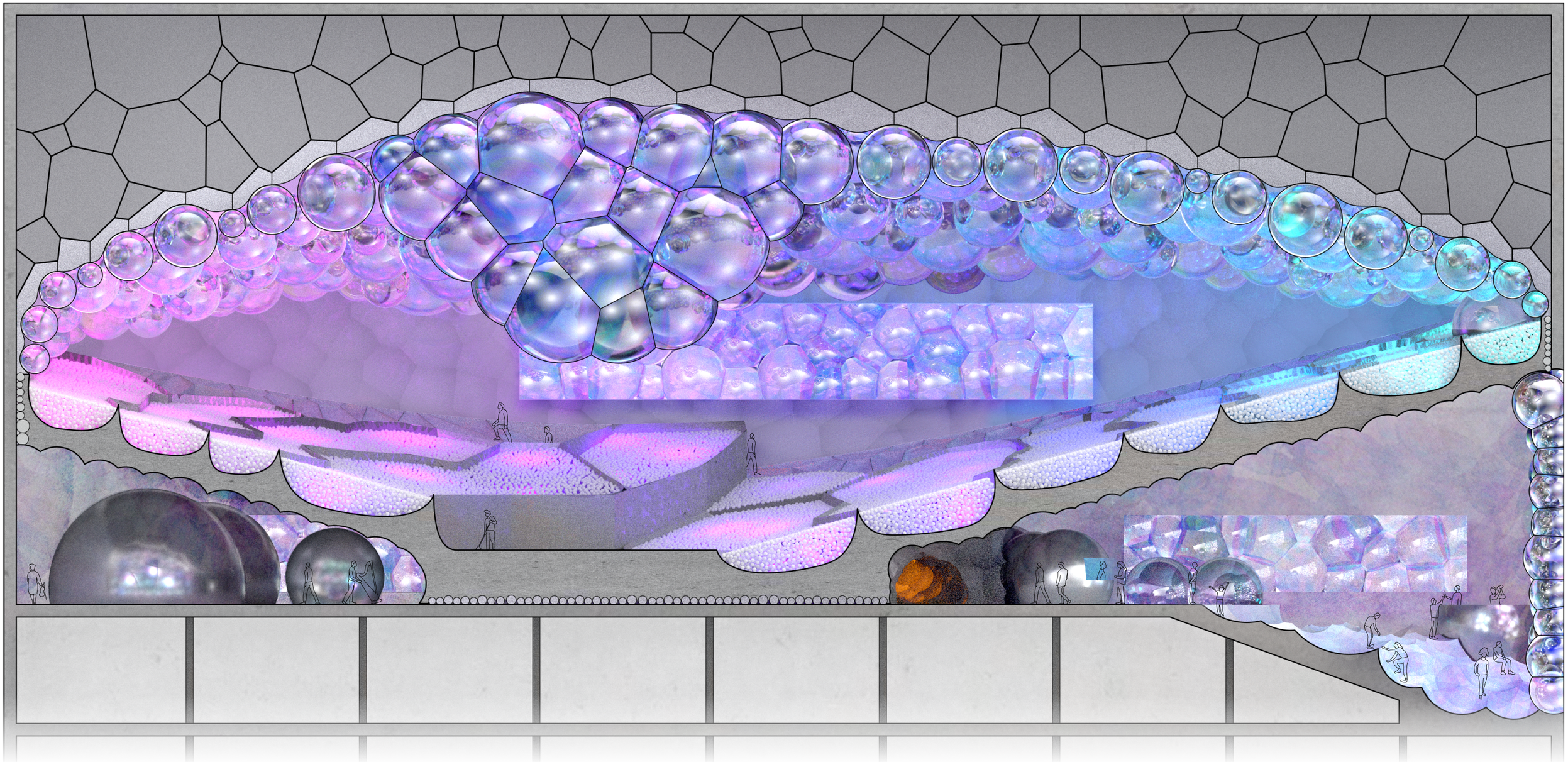
So where were we heading? If our destination was a symphonic orchestra, this is where we find our seats, bubble pools. Along with our fellow concertgoers we swim to our assigned pool, get comfortable and allow ourselves to be embraced by bubbles and music. Was it a pop concert you say? Then we already met the bubble pools out in the foyer, which now leaves the terraces of the pools in the concert hall empty and just waiting for a dancing crowd!









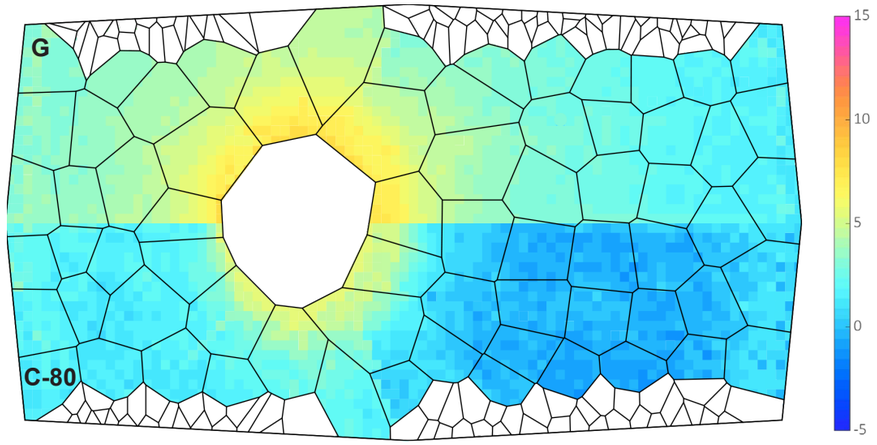


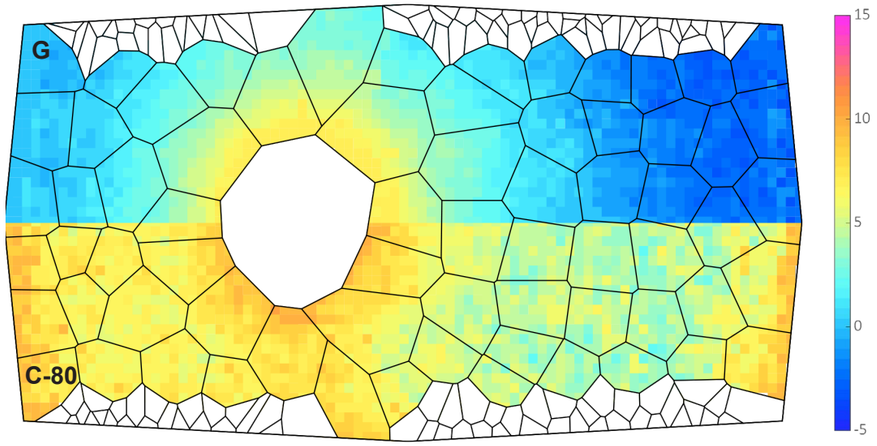
Scale 1:100

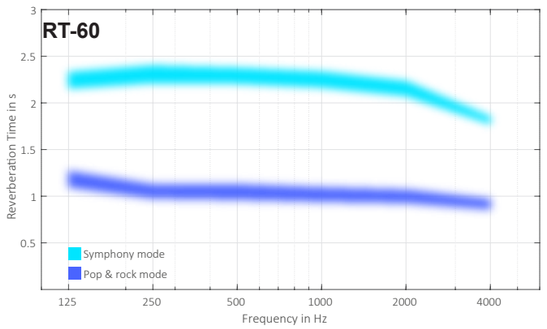
A hall for music

A concert hall is nothing without its acoustics. Several acoustical challenges were to be overcome in this project. The stage is surrounded by the audience, no doors and the stage is to be used for two very different kinds of music, both symphonic orchestras and rock concerts. The key to solving this has been the interplay of volume, material, and geometry.

The entire ceiling of the concert hall is covered in bubbles hanging from a system of bubblebars, forming a bubble space truss system. These bubbles, with their convex surface, makes sure that the sound is distributed evenly throughout the vast space. As a result, the clearity (C-80) and strength (G) lies within a desirable range throughout the hall, with a higher clarity on pop and rock concert than during a symphonic.



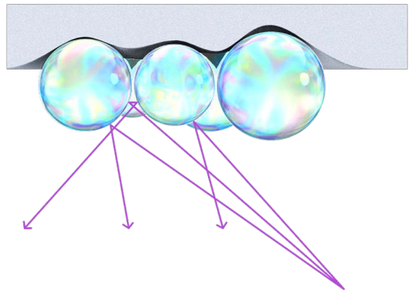




Symphony mode

When the orchestra is playing, reverberation time has to be increased to the desired 2 seconds. This is mainly done by maximising the sound's path length before a reflection and decreasing the absorption area. Glass bubbles are lifted up into the highly absorbant flexible polyurethane foam, creating a reflective ceiling instead. The stationary crown of bubbles over the stage reflects the sound in all directions, including back to the musicians. The audience is submerged in the absorbing bubble pool of foam-filled bubbles. This ensures that the room will have the same absorption coefficients whether the audience is present or not.

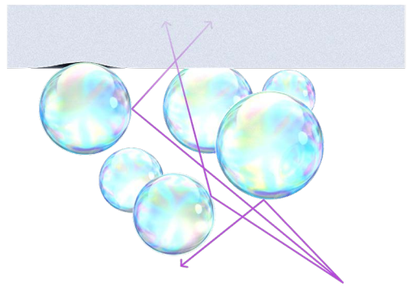
In order for the audience to be perfectly comfortable in the bubble pools, the temperature of the room is set to be 22±2 °C with ventilation from undernieth and through the bubbles. Furthermore, the umidity of the room needs to be controlled in order to inimize the risk of bacteria growth as well as keeping a fresh feel.



Pop & rock mode

For the rock and pop concerts the room has to be altered, not only functionally, but also acoustically. A reverberation time of 1 second is desired, this without the help from the highly absorbing bubble pool. The glass bubbles are lowered to expose the roof's absorbing polyurethane foam, and effectively increasing the surface area of the glass bubbles, thereby increasing both absorption and scattering. Instead of reflecting all of the sound back down to the audience, the bubbles now reflect a portion of the sound upwards to the absorbant ceiling and some to the audience.

As the hall enters the pop and rock mode, there are more shanges that appearence, the room also changes climate. Dubbeling the audience in number as well as having them dance does directly lead to a hightened temperature and humidity. As the audience will be in the mode of the experience of a concert, a higher temperature of 25±5 °C is accepted as well as a higher humidity.

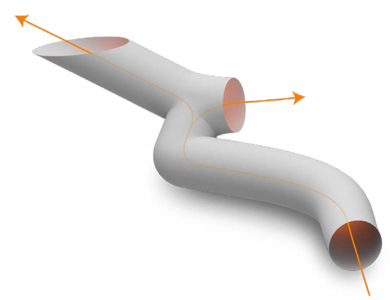


Searching for perfect bubbles

In deciding on the bubble pools, we needed to physically test it. How does it feel to be submerged by bubbles? What size, softness and material should be used? And how much noise do they make?All these parameters were taken into consideration in desiding on the bubbles for the pools. The decision landed on a diameter of 160mm, foam filled and a slooth surface. The size made the bubbles have the same proportions to an adult as the balls in a childrens ball-pool have to a child, increasing the feeling of childishness. Also, larger bubbles allow for a greater airflow through the poop, as the gaps between bubbles are greater. The foam made them more absorbent as well as ledd noisy and the smooth surface made cleaning easier.

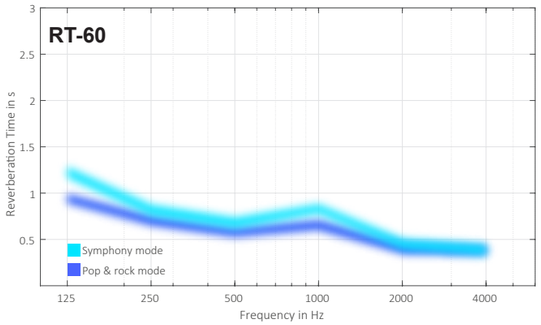
No doors

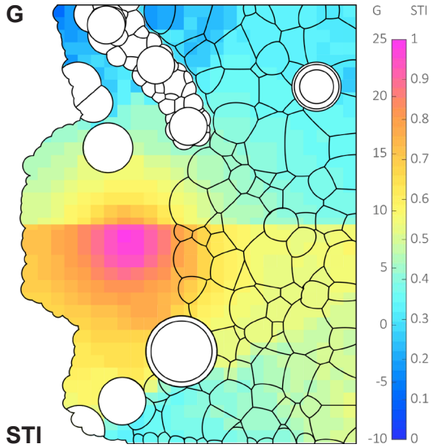
Keeping true to the concept of bubblespaces, where the overall room is created from the bubbles that fill the space, doors simply do not fit. Still, no noise from the foyer is to disturb the experience of the concerts. Therefore it is up to the corridor to make sure that no noise bleeds through from the foyer to the concert hall. To reduce the sound travelling through the corridor the highly absorbant bubble concrete is used, as well as the geometry of the bubblefossils which scatter sound and reflect it back into the foyer. Finally the opening into the concert hall is as vertical as possible, creating a sharp turn, and projects any remaining sound upwards into the empty air.

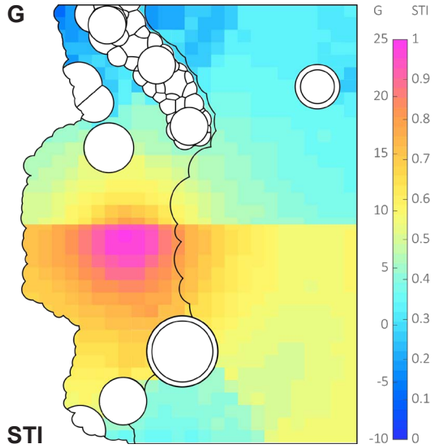


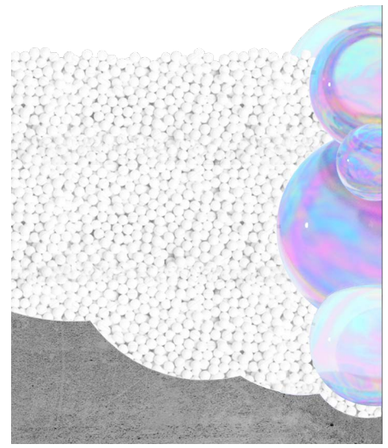
Not your ordinary foyer

No matter if the foyer is partly filled with an absorbing bubble pool or exposed bubblefossils, it has to work either way. As the space is to be used for both relaxed conversation and more formal talk, the speech transmission index is to be around 0.6. To do so, the bubbles in the windows are used as Helmholtz resonators, absorbing a variety of frequencies. As the room is filled with the bubble pool, the openings of the helmholtz resonators are covered allowing for approximately the same speech transmission index on both occasions.



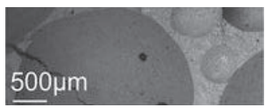


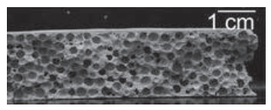




Bubble concrete

The bubblefossil concept runs through the building from the macroscopic level to the microscopic. When cement and hydrogel bubbles are mixed together and left to dry the hydrogel evaporates leaving imprints within the concrete. These imprints are similar to the bubblefossils on the walls and floor. The concrete increases in porosity, increasing its sound absorption capability. For standard concrete the absorption coefficients are about 10%, whereas in this concrete it increases to about 60% for frequencies above 500 Hz, with absorption of some frequencies up to 80%. Though the size and number of pores can be altered to fit the absorption requirements of the space.



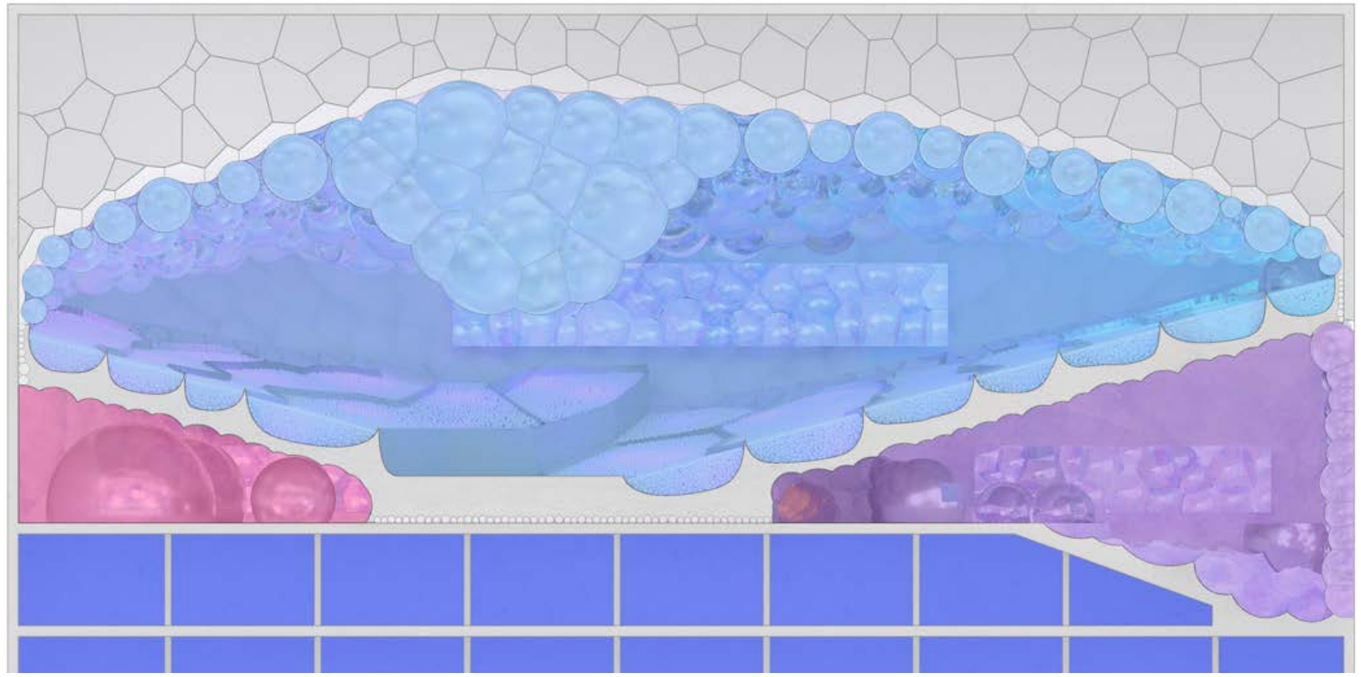


The Hall
Volume: 20 000m³
Approx. sound level: 110dB

The Foyer
Volume: 7 000m³
Approx. sound level: 80dB

Backstage
Volume: 3 500m³
Approx. sound level: 70dB

The Offices
Approx. sound level: 60dB



A climate for exploring

Several aspects reguarding the indor climate must be taken into consideration to create the right experience. As the context of the building is in a buisy town, with an airport departure rute going just over the building, noise from the outdoors are expected. Therefor the concert hall is detached from the exterior structure and hangs in a system of hydrolic rods. To minimize the spreading of vibrations from the hall to the offices, having the greatest difference in sound level, the hall is placed on resilient bearing. The greatest amount of people which will be attending a concert simultaiously is 2000 people. This then becomes the dimentioning value for ventilation. The 2000 peope are expected to be dancing, hence requering a netilation of around 10 l/s & person resulting in a ventilation system for 20 000 l/s. As the visitors are to leace coats and shoes in the wardrobes, a comfortable floor temperature is recuired, using floor heating.