Personal Information
Name: Martijn van den Berg
Student number: 4183541
Address: Van Lynden van Sandenburgstraat 3
Postal code: 2613CJ
Place of residence: Delft
Telephone number: 0636136515
E-mail address: martijn.johannes@gmail.com

Studio
Name of studio: Architectural Engineering

Teachers:
Anne Snijders, Martin Tenpierik

Argumentations of choice of the studio:
In the last study-year, I discovered my fascination for building physics. During my study, I often discovered the urge to calculate things to know how and if things work and to value them in a more objective way. Especially during Zero Energy Design I enjoyed the engineering part. In AE/T, there is the possibility to combine Architecture and Engineering, and to create a very specific research question.
Problem Statement
In many of the redeveloped buildings, the acoustic quality is very poor. The reverberant times are very high due to the little amount of absorbing surfaces and some frequencies gain a higher G-strength than other frequencies. This is for a part due to the dimensions of the spaces. For example; churches with concave surfaces and very high ceilings. The other part is caused by the materialisation of the buildings. The materials are mainly chosen because of their constructive or aesthetic properties. The masonry and concrete hardly absorb any frequencies, which causes a high reverberation times, and wooden floors basically absorb a little bit of the low tones (due to the resonance frequency).

However, some buildings could be very suitable for theatres and arts centres because of their central location in cities, but due to the poor acoustic quality this is a big design challenge. In the design question, two important demands conflict with each other; Both the cultural value of the existing building and the acoustic quality demands large surfaces. Cultural value needs to be seen by the users, but sound needs to be absorbed and reflected in a complex way. How can heritage be a place for music?

Objective
Since some existing buildings are, due to their location and cultural and historical value, a perfect place for public leisure functions. A lot of public spaces demand high acoustic quality, like music halls, theatres and auditoria. What measures can be taken to improve acoustic quality in existing buildings so that rock and pop music performances can take place?

Apart from furniture-like measures in rooms, a good music-hall needs a tailor-made design, which is very specific. Since every existing building has its own dimensions and their own cultural and historic qualities, the research is taken place in a very specific place.

Overall design question
How can the Van Gendthallen be redeveloped into a place for music?

Sub-questions
- What particular program fits the Van Gendthallen?
- What are the (acoustic) demands of the program?
- What are the cultural values, which need to be displayed and/or preserved?

Thematic Research Question
With what unconventional techniques can the acoustics be made suitable, and in which way are the acoustics changed?

Sub-questions
- What criteria are there for rock and pop venues?
- What precedents have uncommon acoustic solutions?
- Which architectural possibilities are there at disposal?
- How can the criteria be quantified?

Background questions
- How does CATT acoustic simulate acoustics?
- How can you calculate and simulate the objective parameters?
- How do you model solutions and buildings?

Methodologies
To research the different solutions to achieve very good acoustic qualities inside monumental buildings, a variety of research methods will be used.

Literature Study
Starting with a literature study to identify the different acoustic criteria for a theatre, and how to calculate or measure those criteria.

Reference Analysis
Parallel to this literature study, different precedents will be analysed on the
way their unconventional acoustic solutions work. The four cases that will be researched:
- The acoustic chandelier of the Rijksmuseum, Amsterdam
- The Glass Music-hall in De Beurs van Berlage, Amsterdam
- Laurenskerk, Rotterdam
- Casa da Musica, Porto

*Pose and design a series of acoustic solutions*
Based on precedents and literature study, a series of acoustic solutions will be developed, and made suitable for the Van Gendthallen.

*Calculation and simulation*
After several possible solutions have been identified and specified, they will be calculated and simulated within a previously specified research framework. Acoustic simulation will be done using a ray-tracing method in CATT acoustic. The calculation and simulation will be used to adjust the series of solutions by iterating (trial and error) and/or creating equations with existing formulas which deliver necessary data.

*Relevance*
Creating an acoustic design for a building is very specific, because it all depends on the existing building. The exact results of the simulation does only apply to the Van Gendthallen. However, the effect of the solutions is generic. If a solution seems to decrease the reverberation time, it is likely the solution will do the same in a different case. In this way, a rough toolbox is created, adding new tools to both the architect and the acoustician.

*Literature*
*Books:*
Blok, R. (2006), Tabellen voor Bouwkunde en Waterbouwkunde, 9th edition,
Wenger Corporation (2000), *Acoustic problems & solutions*
*Websites:*
CATT Acoustic (2015), www.catt.se