MUSIS SACRUM ARNHEM

ACOUSTICS OF THE PARKZAAL AND THE MUZENZAAL

ACOUSTICS IN THE HISTORY OF MUSIS SACRUM

Musis Sacrum has undergone radical changes in recent years. The former Parkzaal has been demolished and in its place a new concert hall has been erected. It can rightfully be called the Parkzaal as it offers a lovely view of the park. The original concert hall was renamed Muzenzaal once its renovation was complete.
The acoustics of both concert halls was of utmost importance during the architectural competition in 2014 and right up to the official opening in 2018. This brochure explains how the acoustic objectives were formulated and how they are integrated into the design and implementation.

The history of Musis Sacrum is larded with acoustic ambitions. Established for the organisation of a song festival, the building with two halls opened in 1847. In 1852 a third hall was added to the complex. None of the three halls, however, fulfilled the desire to have a real concert hall in Arnhem. As a result, the 'Nieuwe Zaal' was renovated in 1865/1866 into a concert hall according to a design by city architect F.W. van Gendt, the eldest brother of A.L. van Gendt, the architect of the Concertgebouw in Amsterdam (est. 1888).

However, the new concert hall proved to be too small for the desired repertoire. It was therefore decided that it would be demolished to make way for a new concert hall. The result is the now well-known characteristic brick building with onion-shaped domes, which since 1889 has been used by the Arnhemsche Orkest Vereeniging.
After the Second World War, a large-scale renovation did not begin until 1982. At that point the Grote Zaal and the Tuinzaal were demolished and a new Parkzaal was built; the existing Concertzaal was renovated.
In 1995, the Concert Hall was expanded with a stage expansion and behind it a choir stage.
Despite all of the ambitions, rebuilding and renovations, the Musis Sacrum concert hall never reached the volume of concert halls that over the centuries have become 'the standard' for the larger symphonic works. With the refurbishment of 1995, a volume of approximately 9,500 m^3 was realized, which is very limited in relation to the Concertgebouw in Amsterdam (approximately 18,000 m^3) or the Goldener Musikvereinssaal in Vienna (approx. 15,500 m^3).



Above from left to right: Concertgebouw Amsterdam, Goldener Musikvereinssaal Vienna and Boston Symphony Hall

ACOUSTICS AND GEOMETRY

Good acoustics is acoustics that suits the function of a hall. For example, 'good acoustics' for a pop venue is very different from 'good acoustics' for a concert hall for symphonic music. A hall for symphonic music must meet a number of conditions. After all, the task is not simple: enabling the sounds of about 80 to 100 different instruments, with different acoustic properties, to merge into a larger whole that is completely in balance and that can be optimally experienced at every listening position in the hall. The correct size is the most important basic condition for the acoustics. The required volume of a concert hall is not so much related to the number of audience members, but the orchestra composition and the desired repertoire are decisive.

Over the centuries, a reverberation time of about 2 s has become the optimum for symphonic music. The reverberation time is the time that elapses between stopping the source of a sound and a 60 dB reduction of the sound. At about 2 s reverberation time, the mixing of the instruments and sound development is considered optimal, with sufficient maintenance of definition or intelligibility. A shorter reverberation time makes the sound 'too dry', which is especially detrimental to mixing and the sound development of the string instruments.
At this optimal reverberation time, a passage played by the musicians as forte should also reach the listeners as forte: loud, with impact, but it must also be even louder. How loud a piece of music is depends (aside from the orchestra) on the 'loudness' of the audience. The loudness of a hall depends on the reverberation time and on the volume of the hall. So if a concert hall has an optimal reverberation time of about 2 s, then the volume is what can be adjusted to realize the optimum loudness. Thus, a hall that is too small is always too loud and a hall that is too large will never be loud enough.

In addition to the volume, the proportions of length, width and height are also important. The feeling of 'being surrounded by music' is generated by strong horizontal reflections, which arrive at the listener before the reflections via the ceiling. A concert hall for classical music should therefore not be too wide, and should have sufficient height.

The Parkzaal: left the exterior, right during the opening concert

ACOUSTICS IN THE DESIGN SKETCH

In 2014, the Arnhem City Council organized an architectural competition in which the program of requirements called for a new multifunctional hall primarily for the performance of non-amplified music for 1,000 audience members. In addition, amplified music concerts and other activities must also be able to take place in this hall. The program was based on a new hall with a volume of approximately 10,000 m^3.

Van Dongen-Koschuch architects, at the request of Peutz, investigated whether a much larger hall could fit spatially and financially within the set framework. The joint competition design became a hall concept based on a rectangular 'shoebox' model following the well-known concert halls in Amsterdam, Vienna and Boston. With a height of over 15 m and a volume of 15,500 m^3, the design far exceeded the requirements, but with good starting points for concert hall acoustics.

Parkzaal after renovation: set up for classical music (left) and for amplified music (right)

DEVELOPMENT OF THE ACOUSTIC DESIGN

Even with the right starting points, a hall is far from finished. Besides the further development of the acoustics, a lot of technology has to be integrated into the hall, such as climate control and theatre technology. Moreover, the building must be able to stand and it must be sufficiently safe. And that is how the design process starts: every two weeks gathering around the table, devising solutions, discussing, and then everyone going home to do their own research and discussing again. In this way a nice plan grows into a realistic structure.

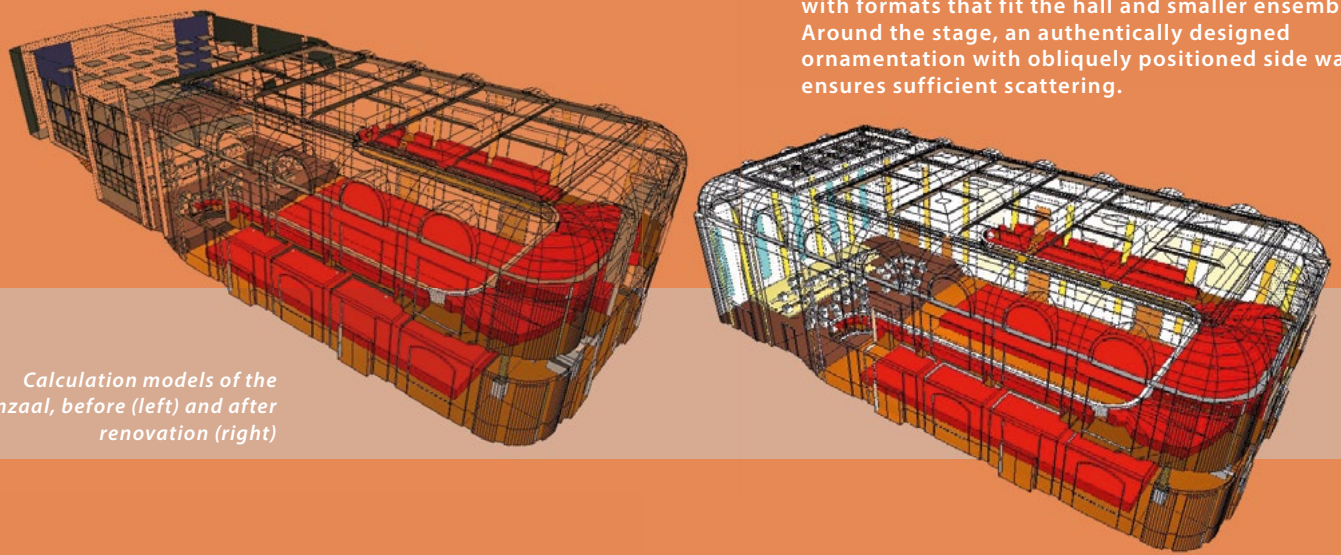
Parkzaal

Although a shoebox is a good starting point for a concert hall, with the current sleek designs in architecture it is not easy to generate sufficient scattering. For a durable, beautiful design, the acoustic measures must be incorporated into the architecture and be one with it. The shape and extent of the diffusion (scattering) was intensively investigated with the aid of a scale model. The design provides, where necessary, large depth surges and an irregular pattern to achieve an even distribution of the sound over the listening positions.

In addition, much attention was paid to the size and shape of the stage. For the musicians, it is important for the interplay that the stage environment generates early reflections that increase the mutual audibility, without increasing the loudness too much. For amplified music, the reflective walls required for classical music actually interfere. For these occasions sound-absorbing panels can be brought out of their cabinets and placed in front of the walls. This gives the Parkzaal the unique ability to offer the ideal acoustics for both classical music and pop music. The structure of these broadband absorbent panels was designed by Peutz. The vast majority of the walls can be covered with these panels which were specially developed for Musis, so that the hall is transformed into a pop venue not only acoustically but also visually.

Muzenzaal

The arrival of a new Parkzaal with sufficient volume has made it possible to finally abandon the attempts to continuously expand the original concert hall. The purpose of the renovation was to carefully remove the elements added in the past and to restore the hall's former lustre as much as possible. The choir stage and the stage enlargement which were added in 1995 have been removed and replaced by a stage with formats that fit the hall and smaller ensembles. Around the stage, an authentically designed ornamentation with obliquely positioned side walls ensures sufficient scattering.



Calculation models of the Muzenzaal, before (left) and after renovation (right)

SILENT ACOUSTICS

To maximize the dynamism of the music, it is important that a hall is silent. Climate-control installations, especially for ventilation, must not be audible. The Parkzaal therefore has its own separate air-handling units that deliver the air at low speed to and from the hall with a large number of silencers, but without control valves.

The Parkzaal has a double shell around it: a concrete outer construction with wooden diffusion panels as well as an inner structure, double glass fronts and large locks for access. The new building is furthermore fully decoupled from the existing building. This guarantees both internal sound insulation and sound insulation from and to the outside. Lock constructions have also been realized around the Muzenzaal with sound-insulating doors. This was done in part to achieve substantial sound insulation between the halls, but above all to make simultaneous use of the rooms around the hall possible.

ACOUSTICS 1:10

The acoustic research for a hall usually starts with calculations on a 3D-computer model in which the basic form of the hall is examined and optimized. In acoustic calculation models, sound is modelled with rays, while the wave character of sound is only included to a limited extent. For the design of the early reflections and scattering, it is important that the wave character of sound is involved in the research. Starting in the design phase, the calculation studies have therefore been supplemented with a 1:10 scale model.
In scale model research, the frequencies scale up, where the sources and microphones are adapted, but the physical propagation of sound is completely preserved. The scale model is thus used for more detailed design studies of walls, ceiling and echo chamber.

Scale model 1:10 of the Parkzaal

ACOUSTICS DURING THE BUILDING PROCESS

Even after the construction has begun, there are usually some final decisions that must still be made. Several suppliers must demonstrate that their products meet the set specifications; the acoustic properties of the most critical products are tested in an acoustic laboratory.

The most eye-catching novelty, the large open front has been tested for sound insulation in Peutz's acoustic laboratory. Previously there were no sliding doors with which a sound insulation of 55 dB could be realized. Thanks to the double construction, in combination with a clever design for positioning the rails, this sound insulation has been realized.

In a concert hall, the chairs realize the vast majority of sound absorption. This implies that a small deviation from the performance requirements of the chairs has major consequences for a hall's acoustics. The hall's chairs were therefore tested and adjusted in the acoustic lab until they met the performance requirements.
Furthermore, checks were carried out as soon as possible with vibration and sound insulation measurements.

Musicians from Het Gelders Orkest during Construction Day, May 2016

Bird's eye view of the building of the Parkzaal

Measuring the sound absorption of the chairs in the acoustics laboratory

THE RESULT

The new Parkzaal was put into operation on 6 May 2017. Due to setbacks in and around the existing building, the planning was extremely tight. The chairs were brought in at the last moment, and the contractor was still sanding the wood during the orchestra rehearsals. But thanks to a concerted effort the first concert was made possible.

Completion measurements have shown that the acoustic objectives have been realized. Both for classical music and for pop music, a nice smooth sound field has been realized.

The degree of variability is high: from a maximum of 2.5 s reverberation time to 1.1 s if all facilities are used. From the very first orchestra rehearsal, it was clear that the hall combines a warm, rich sound with a high degree of musical intelligibility. Het Gelders Orkest sounds like never before in the new hall. This would not have been possible without the pleasant and indispensable collaboration with clients, architect, other advisers and executing parties, both during the design and the realization.

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