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45 years in acoustics: A personal account

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I started in 1967 with the Sydney Opera House, and I am still going strong with a Culture House in Molde (N) by 3XN and an opera house in Izmir, Turkey, and other projects.

After returning from Sydney in late 1973 I joined with Vilh. Lassen Jordan and made concert halls in Odense, Dublin, Oslo and Stockholm. In 1982 I took over the practice. With engagements in Toronto for a Performance Studio for the CBC, a Chamber Music Hall in Calgary for the University, and latest a renovation project for the two Jubilee Halls in Calgary and Edmonton for the Alberta Government. In between projects for a National Opera House and a Presidential Concert Hall, both in Ankara. To assist me in these projects, I have worked with A. C. Gade, Jens Holger Rindel and Claus Riis.

My advice to you: Room Acoustic consultancy requires a personal 100 % engagement, the ability to listen and understand aspirations of the architect the client and the users. And a thorough reporting on your recommendations.

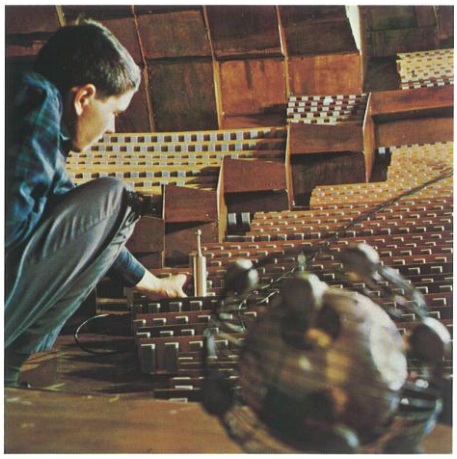


Fig. 1. Utzon' latest design for the combined opera and concert hall design.

Also the first design by the AUS' architects for the sole concert hall. Neither would work acoustically, since the volume was too small to achieve desired reverb, and sufficient lateral reflections could not be created.

The final design of the concert hall was build in model.
Now the volume was increased creating a high uninterrupted space, where the audience is placed somewhat tucked in on high side terraces and on the main floor. This design proved to be successful and was adopted.

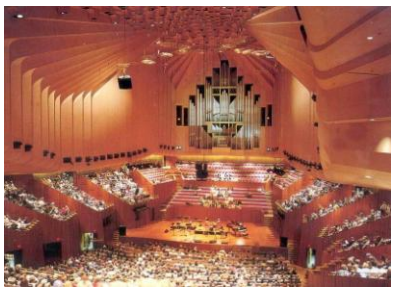


Fig. 3. Concert hall as build under the big shell system.

You notice the protrusion of the shell systems as the limiting factor for the volume. The raised side terraces also around the podium allows for the demanded (by ABC) 2800 seats to be met. You will find more information in "Acoustical design of Concert Halls and Theatres" by Vilhelm Lassen Jordan, 1980.

Fig. 4. Metropolitan Opera.

Notice balcony fronts and proscenium frame.
These design features were developed during the model testing phase, and were the determining factors for the successful acoustic results in this 3.800 seats opera. So far the largest hall relying entirely on natural acoustics.

Fig. 5. National Concert Hall in Dublin.
Model and as built.

This concert hall is created in the former assembly hall at the UNI, keeping the upper walls and the ceiling intact. I believe the model is still placed in the DTU cellars.

Fig. 6. Oslo Concert hall at inauguration.

A difficult design as the appointed lot had a rectangular shape. This form was moderated by the stepping in the side wall cladding, creating Lateral reflections towards the audience. The steep rise of the terrace at the back ensures that the floor area still receives early reflections.
Different designs of reflectors over the podium were tested in the model, but were never implemented.

Fig. 7. Berwald Hall, at SR in Stockholm.

Designed as a recording studio with high clarity values. The hall was never fully appreciated by listeners, and the facility to prolong the reverberation by closing the slots in the side walls, were to my knowledge, never carried out.

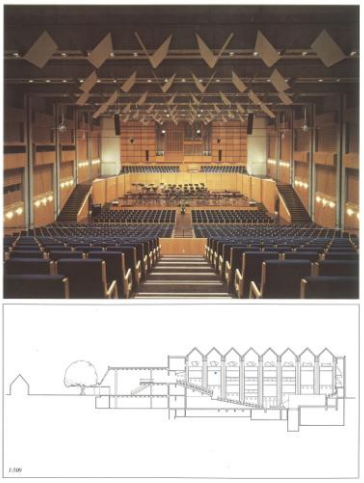


Fig. 8. Carl Nielsen Hall in Odense Concert and Congress center.

This hall has since its inauguration been claimed to be the best traditional concert hall in DK. Formed as a classical shoebox, it obtains acoustic criteria well within optimal range. This was the last hall for which V. Lassen Jordan was responsible acoustician.

Fig. 9. Umeå multipurpose: Theatre, Opera, Concert Hall.
Model and as built.

The cardboard models illustrates how the side walls can be angled towards the audience in a position for theatre, and for opera by extending flaps in the walls, at the same time exposing an orchestra pit. For concerts the side walls are returned to the parallel situation. The ceiling consist of a series of reflectors normally parked vertically in the stage tower, but horizontally placed is closing off this tower. The whole ceiling over the audience is a walkable open grid of "Elephant" grids hinged giving access for stage lightning and loudspeakers. At the same time exposing a huge void, where curtain tracks ensures that the right reverberation can be obtained for the actual performance.
Miklos Ölveczky was responsible for the stage technical facilities.

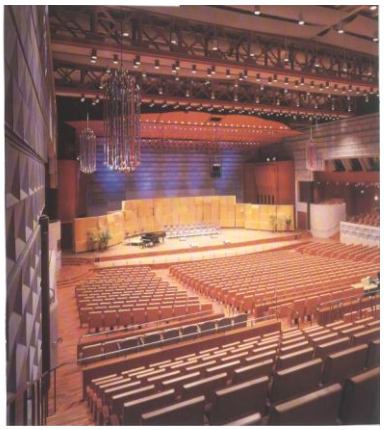


Fig. 10. Linköping Concert and Congress Centre.

Also in this hall it was essential that both concerts, opera and congresses could take place. This also requires a variable acoustic system, Also here placed in the ceiling between light bridges. An elaborated stage changing between concerts and opera was created.

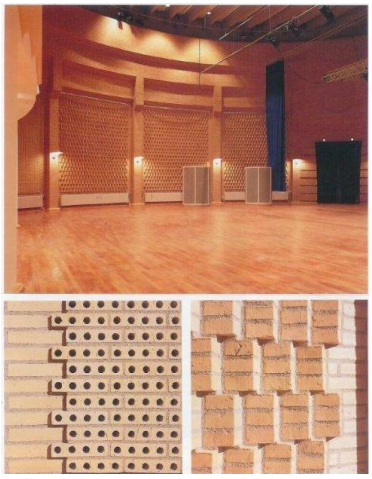


Fig. 11. Hørsholm multipurpose: Side and end walls.

This cylinder formed auditoria, favored by the architect, was acoustically treated to make it sound like a rectangular hall. This was obtained by making the two "side walls" (the three infills between columns) highly diffuse with the shown brickwork, drawing them closer to the audience from a listening experience. The two "end walls" are made highly absorbent by the shown brick with holes, resulting in a larger distance to the audience from a listening experience. The trick worked perfectly deleting the focusing effect else to be expected.

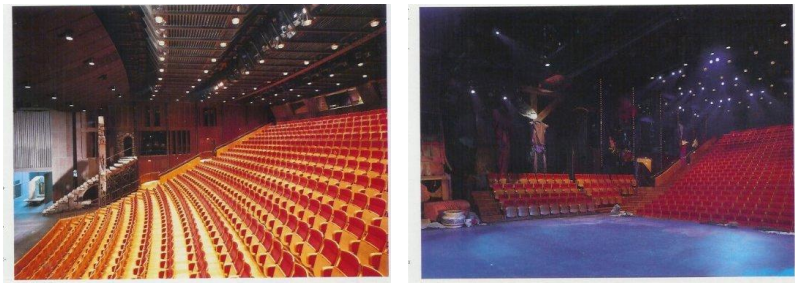


Fig. 12. Norske Theater, Oslo:
Flexible settings.

This is also a Miklos Ölveczky theatre design, where the side walls can be either fully open or partly open by the use of louvers. Seating also takes place on movable Sections, moved around on air cushions. The acoustic challenge was to obtain a high speech intelligibility level for all the possible settings. A steep sloping of the main floor (also favored by Miklos) would ensure this. The actors didn't find it to their advantage after it was taken in to use.

Fig. 13. Swedish Radio: Performance Studio.

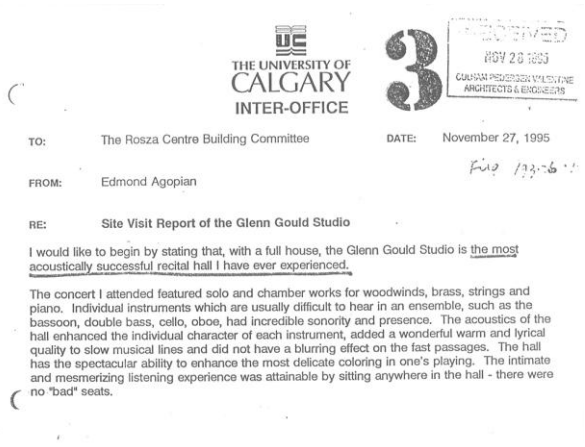
In 1988 my Canadian adventure started. I was asked to come to the planned new headquarter for the CBC in Toronto. They had found me from a visit to SR in Stockholm, where my father had made a performance studio, that they liked. I had to go to see and study it before I went to CAN. After my presentation I was offered a contract to design their studio. I insisted that I had to work with an architect. They used the Philip Johnson office from N.Y., which actually was the same my father did the N.Y. State Theatre with.

Fig. 14. Glenn Gould Studio, CBC, Toronto.

As you might guess I was left with far too little floor area, since all the columns and slabs were in place. I pushed the side wall areas in between these constraints outside of the hall, And created what you might call windows hung with heavy "curtains" of molded gypsum plaster, hence creating diffusiveness from walls and ceiling.
A special feature were the side elements on the podium. They were angled partly also to give reflections back to the performers. This was end of CAN. I thought.

A music professor at the Calgary UNI, who had been given a donation for a chamber music hall. The architect came to see me, and I got a contract to be his acoustician although Artec and others grumbled. The hall was designed as a classic western barn with pitched roof. I got sufficient volume, and now used the Odeon program to check the design.

Prof. E. Agopian verdict. “Site Visit Report of the Glenn Gould Studio”:
"I would like to begin by stating that, with a full house, the Glenn Gould Studio is the most acoustically successful recital hall I have ever experienced." [1.)]



THE UNIVERSITY OF CALGARY
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RECEIVED
NOV 28 1995
GULAYAM PEDERSEN WILSON INC
ARCHITECTS & ENGINEERS

TO: The Rosza Centre Building Committee
DATE: November 27, 1995

FROM: Edmond Agopian

RE: **Site Visit Report of the Glenn Gould Studio**

I would like to begin by stating that, with a full house, the Glenn Gould Studio is the most acoustically successful recital hall I have ever experienced.

The concert I attended featured solo and chamber works for woodwinds, brass, strings and piano. Individual instruments which are usually difficult to hear in an ensemble, such as the bassoon, double bass, cello, oboe, had incredible sonority and presence. The acoustics of the hall enhanced the individual character of each instrument, added a wonderful warm and lyrical quality to slow musical lines and did not have a blurring effect on the fast passages. The hall has the spectacular ability to enhance the most delicate coloring in one's playing. The intimate and mesmerizing listening experience was attainable by sitting anywhere in the hall - there were no "bad" seats.

Fig. 16. Prof. E. Agopian.
“Site Visit Report of the Glenn Gould Studio”

Fig. 17. Esbjerg Musikhus.

In the meantime I worked with Jan Utzon on the Esbjerg multi performance hall. We used hoistable ceiling elements to create the right volume and reflection patterns for an actual performance.
The volume changes turned out to be of lesser importance than the reflection patterns.

Fig. 18. Rosza Centre. Calgary UNI, Alberta.

This hall was claimed by the Dean of the music department to be second to none in North America. The barn structure was well suited for this type of hall.
Early lateral reflections are created by the cylindrical beams running along the sides. The stage features the same elements as in the Glenn Gould Studio, returning reflections towards the performers.
This was the end of Canadian challenges I thought.

Fig. 19. Gothenburg Konserthus.
Open Reflector.

Next challenge was the ensemble conditions on the stage. Mounting complaints over a large reflector build in the eighties led us to test several ideas with the orchestra in full scale. We didn't get a clear answer to our questionnaires. But I pursued my believe, that the reflector was wrong, since it closed off even more of the precious volume above, and only worsened the imbalance within the orchestra favoring the heavy instruments. Originally no reflector was envisaged, it was introduced to hide the big organ pipes placed on top.
I came upon the idea to design an open reflector, letting most of the orchestra sound through to the volume above, at the same time still returning sufficient energy to the orchestra to enhance the ensemble.
That was actually what we had experimented with in the Oslo konserthus model.
This design was appreciated by the orchestra members, conductors, and the director of the concert house. Following we got an invitation to come to Stockholm to investigate the conditions on the podium.

Sture Carlsson verdict: "Vi tycker nog, att vi nu har "Världens bästa Konserthus". - Att det nu har blivit i det närmeste perfekt är til stor del din förtjänst. "Sammenfatningsvis tycker vi, att du är den bäste rådgivare vi kunnet få." [2.)]

Fig. 20. Stockhom Konserthus, Testing.

We also found other grave faults in this hall, especially in the ceiling void. The testing was not successful, but that was due to faults in our equipment, not in the ideas we presented. Anyway our engagement was short and I don't know whether any of our recommendations have ever been carried out.

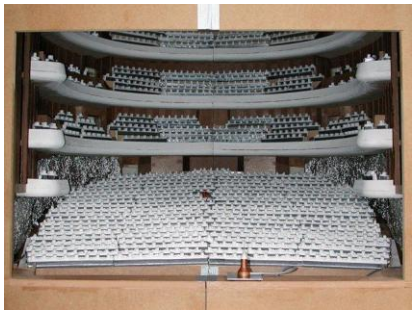

Fig. 21. Ankara Opera Model, Turkey, not build.

This Turkies challenge came out of the blue. The architect Özgür Ecevit called and said I should be his acoustician.
He had won a combined competition for an Opera House, Drama Theatre and a Multipurpose Hall to be placed in Atatürks memorial park. I had previously helped him in a competition for a Concert Hall he didn't win.
We got a contract for the opera, and the different stages of the project were approved.
Also a physical scale model in 1:10 scale was to be investigated. It was built in DK and tested at DTU by J.H.Rindel.
This is the last physical model I have been involved in. Now Odeon has taken over.
Scientific paper by J.H.Rindel comparing model and Odeon results. [3)]
The project was stopped because of lack of funds. Recently I have made a renovation job with Özgür on the Presidental Concert Hall.

Fig. 22. Jubilee Halls, Calgary and Edmonton as original.

The architect F. Valentine returned with a project for renovating these two halls. You will find them in Beranek's book. Identical 2.500 seats on three levels. They suffered reverb and early reflections like most other halls from that period with fan-shape and low ceiling designs. This time the architect had to put up a fight to get me as acoustician.
Both Artec and others protested to the government to accept a nobody from Europe. The architect won simply by saying, that he would not accept the job without me as his acoustician.

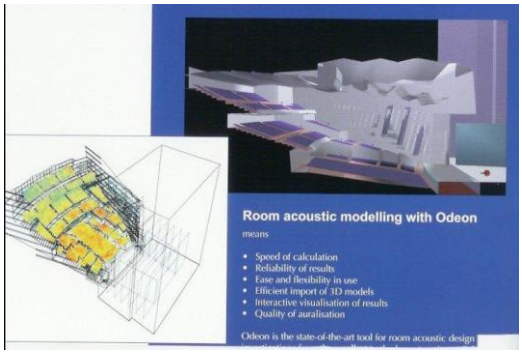

Fig. 23. Odeon model of design proposal for the halls.

This time full scale Odeon testing was used, performed by J.H. Rindel. We broke up the side walls with terraces extending to the first balcony, and further back to the second.
We introduced a big reverberant chamber above a transparent ceiling, and made sure all surfaces would perform diffuse spreading. The aim was to create natural acoustics for opera.
Both cities had by now concert halls of their own. At the same time we should ensure good conditions for road shows, rock concerts, and other types of gatherings. To accommodate for these uses we designed banner systems for both side walls and the ceiling void.

Fig. 24. Jubilee Halls as renovated.

The halls have a much narrower floor area creating early reflections from the side terraces. A more intimate hall with a satisfying reverb was the result.
The sound technicians were not too happy. They found their new Meyer system, center - right - left positioned like in THX cinemas did not work perfectly with the longer reverb. The curtain system was consequently enlarged.
The complaints stopped.
Fred Gilpin verdict: "In my opinion, the acoustics of the Jubilee Auditoria are going to become world famous once more people have had a chance to experience the natural state of the halls." [4.)]

Fig. 26. Kastelsvejens skole for deaf children.

Besides all the thrilling encounters also small jobs are handled. The teachers had found that the children liked the low frequency content in rock music. We designed a vibrating floor equipped with 16 "Buttkickers" free of other constructions. The children hung on to the floor, when they experienced Bruce Springsteen through the vibrating floor.

References:

[1] Prof. E. Agopian. Letter of 27th of November 1995. Can be required from the author on request.

[2] Sture Carlsson. Letter of 1st of October 2002. Can be required from the author on request.

[3] "Room acoustic modelling techniques; a comparison of the scale model and the computer model for a new Opera Theatre". J. H. Rindel. Presented at the proceedings of the international symposium on Room acoustics, ISRA2010. 29.-31. August, Melbourne, Australia.

[4] Fred Gilpin. Letter. of 28th of February 2006. Can be required from the author on request.