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CHALLENGES OF DESIGN OF SMALLER MULTI-PURPOSE HALLS

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Abstract
Most of the literature on room acoustics is focused on the design of concert halls (+1000 seats), chamber music halls, opera halls or actual theaters. However most performance spaces built are actually smaller multipurpose rooms. Often these will be the only venue in the community, implying that the acoustic conditions of the space must function for a very broad variety of performances, everything from acoustic concerts to reinforced music, drama, musical theater, conference and in some cases also as a cinema.

Obviously this requires a high degree of acoustic variability, but quite often these halls are also built with a very limited budget, meaning that expensive moveable constructions are not possible to use.

This paper will discuss the challenges of the acoustic design for these types of venues, based on experience of recent halls in the Nordic countries and Baltic.

Keywords: room acoustic, small halls, multipurpose.

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1 Introduction

During the 20 years from 1980 to 2000, a large number of “Culture houses” were built in Finland. And in the last 15 years, about 10 new halls have been built in Finland and the Baltics.

In most cases, the halls represent the only performance space in the community. For this reason, most of the halls were built as multipurpose halls, in many cases with variable acoustics. The halls are typically used for symphonic music, light music, conferences, theatre performances, danceperformances, as a cinema etc.

From an acoustic point of view, multi purpose halls are more or less compromises. The key features are

- Some kind of proscenium stage
- Changeable acoustics.
- Theater style seating, that is seats with high back rest
- Somewhat steeply sloped seating area

Furthermore most of the halls are comparatively small, typically 300 – 700 seats. Nearly all the halls are ”sold” as concert halls, meaning that the typical repertoire of an orchestral concert in a typical Finnish cultural hall will include a large number of romantic works. [1].

The acoustic conditions of most of these halls have been documented, the halls build before the year 2000 as part of a study done by the author and most the newer halls in Finland as well as in the Baltics, have been documented in a similar way. This database is the basics for analysis in this paper [2], [3].

2 General characteristics of small halls

In comparing the impulse response or large and small halls, the major difference are as follows [6]:

a) level of the direct sound
b) level of the early reflections
c) the time density of the early reflections
d) total early reflection energy (@ 80 msec)
e) directional character of the early reflections
f) level of the reverberant or “late” field energy
g) total sound strength
h) the decay rate of the reverberant field.

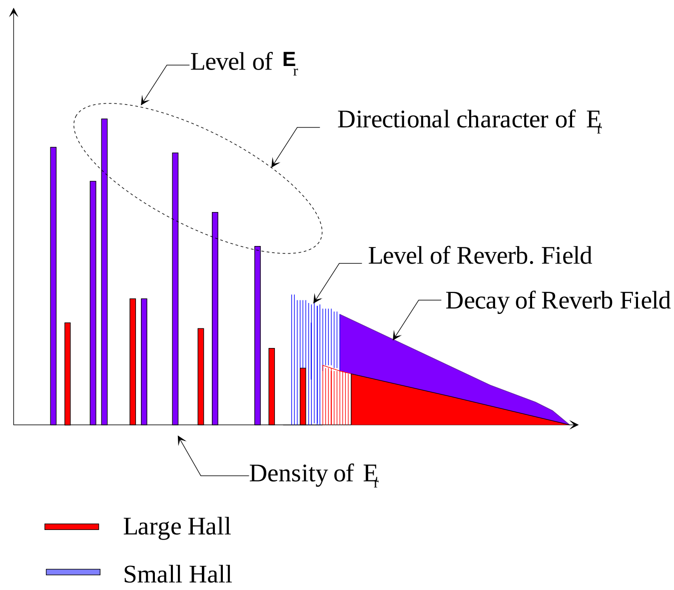


Figure 1: Comparison of principal energy-time-curve of small halls and large halls

A comparison of each of these acoustical issues essentially shows that all the acoustical attributes are greater in value for the smaller, lower seat-count performing space. In other words, a smaller hall (with acceptable reverberation for symphonic music) will be significantly louder than a normal sized hall. And even though it has been shown that spatial impression is composed of the level of the early lateral reflections and the early strength [7], this is not always true for small halls. They will often give a subjective impression of being loud without actually being “spatial”.

3 Design considerations

In the following, some of the main design considerations for the small halls will shortly be described. This paper will focus on the considerations related to the volume of the hall and the variability of the acoustic conditions.

3.1 Hall volume

Traditionally, the volume of a space for acoustic music will be given as volume per seat. This will typically be in the range of 10 – 12 m^3/seat, even up to 14 m^3/seat in some of the modern vineyard halls. As the small hall typically will be used with the same size orchestra as in a large hall, it is sensible to define the necessary volume per musician, not seat. The typical number used in recent designs are 100 m^3/musician, implying that the “standard” size romantic symphony orchestra requires a volume on 9000 – 10000 m^2, independent of the seat count in the hall. [6]

As the floorplan is set by the seating, this will typically lead to quite high halls, with heights in the 15 - 17 m range.

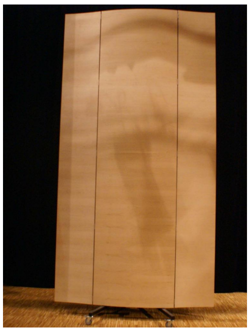
3.2 Stage

The stage size is set by the maximum size of the orchestra. As many of the halls are also used for theater and opera, the basic area of the stage is not a problem, however achieving the sufficient reflecting surfaces for an acoustic orchestra is difficult to combine with the requirements for theatre stageing.

One of the typical problems are the overhead reflectors needed for orchestra ensemble reflections, in particular when using the volume calculation described above. These will normally be in the way of theatre lighing bars and other rigging. In other words, it is essential to design a system where the reflectors are easily removed for other performances and put back in the correct place for acoustic music.

Another typical problem is the need to remove all of the theater curtains used for drama and similar performances, when the hall is used for acoustic music. This will normally be done using curtain parking or pockets which are closed off.

Also the side stage and back stage areas will need to be acoustically closed off for acoustic music. In many cases it is however sufficient to use an “acoustic shell” or separate reflectors standing around the orchestra.




Open Closed (storage)

Figure 2: A simple orchestra shell (Alandica, Mariehamn, Finland)

3.3 Variable acoustics

Variable acoustic conditions are essential for any kind of multipurpose hall. Even the latest dedicated concert halls have some variable acoustic to accommodate different types of orchestra music.

The different schemes for variable acoustics can roughly be divided into two types:

- Variable absorption
- Variable volume

In the later years, also electronic enhancement systems, such as the Meyer Constellation System or the Yamaha AFC system have also been used in halls with considerable success.

The majority of multipurpose halls in the previously mentioned study have some kind of variable absorption implemented in addition to the stage curtains. In the hall built before 1990 there are typically “flip-flops” on the side walls, that is hinged panels, with one hard side and one soft side. The problem with this scheme is that it will normally be difficult to achieve sufficient changeable area to achieve any real change in the acoustic conditions in the hall.

Figure 3: Hinged absorption elements (Lauritius Hall, Lohja, Finland, design Halme Acoustics)

In newer halls (primarily designed by Akukon), curtains are used instead of hinged elements. The advantage of this is that it is normally a cheaper solution and that that is quite easy to achieve significantly larger areas, which means that it is easier to make an audible change in the acoustic condition [5].

Another issue is the placement of the variable acoustic surfaces. As will be shown in the cases presented, the most efficient placement of the variable areas is (in range order):

- Around the stage (stage curtains)
- Across the room (transverse curtains)
- Back wall
- Side walls

Another issue in favor of using curtains is that this makes it relatively simple to use automated systems, ie. “push a button” to change the acoustics.

The problem with curtains is getting sufficient absorption at low frequencies. There are however systems on the market for variable bass absorption, such as the Flex Acoustics aQflex.

4 Design examples

In the following two multipurpose halls will be briefly described to show how the above mentioned guidelines have been used.

4.1 The Schauman Hall, Musikhuset Allegro, Jakobstad, Finland

The Schauman Hall [8] is built to accommodate a wide variety of music. The basic layout of the hall is a shoebox shape, with a maximum of 400 seats, about 60 of them on a rear balcony. The basic dimensions of the hall is width 16,7 m, overall length 23,3 m and height in front the stage is 14 m. The stage height is 0,7 m.

After careful consideration and discussion, it was decided that the design goal for the hall was “a reverberant small opera hall, with variable acoustics to enable use for reinforced music”.
The budget was somewhat limited in AV- and theatre systems, so the main goal for the design was to ensure that all the necessary infrastructure was in place and that the hall had functional systems for normal use. Also the main goal of the stage mechanics is to ensure that there are sufficient lifting points, whereas the installed stage mechanics only include some light bars and hoists to hold the overhead acoustic reflectors.

Figure 4: The Schauman Hall with curtains exposed

Figure 5: The Schauman Hall sidewalls in “hard” mode.

As there are no side balconies, shelves are placed on the side walls. The side walls are mainly “diffusing” with an irregular “saw tooth” structure. Areas of plain wood boards are incorporated for architectural reasons, and they also work as “parking boxes” for the sidewall curtains. The rear wall is also slightly diffusing, but the main scattering comes for the actual rear balcony and other structures.

The variable acoustics are implemented with curtains. There are side drawn curtains on the side walls of the hall and on the rear wall of the balcony. On the parterre rear wall there are roller curtains. The three transverse curtains (ceiling curtains) are also roller curtains.

The stage curtains are designed to function as part of the variable acoustic surfaces. The double rear curtains can be parked behind the stage side walls. The stage side curtains are roller curtains that are stored in a box underneath the technical bridges. Also the main curtain can be stored in a box underneath the ceiling.

There are removable acoustic reflectors above the stage covering approximately 30% of the stage area. This is a compromise between the need for lighting and rigging for theatre/musical and other show applications and the need for the orchestra. However as the hall is not that high and as there are shelves both on the sidewall and the rear wall of the stage, this amount of reflectors has proven to be sufficient.

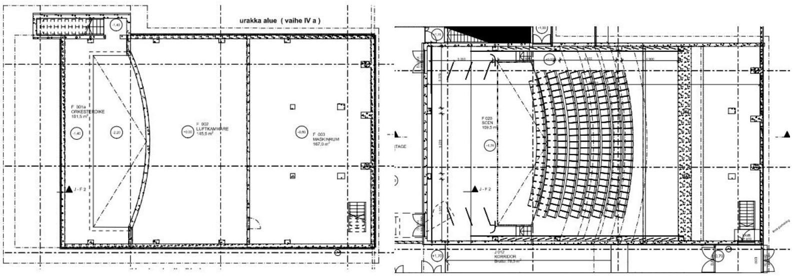


Figure 6: Orchestra pit and stage level plans

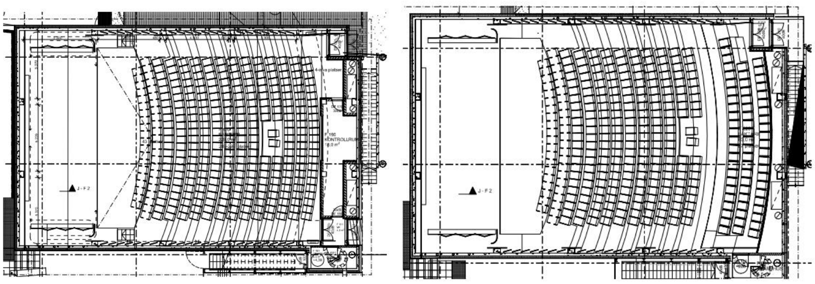


Figure 7: Parterre and rear balcony plan

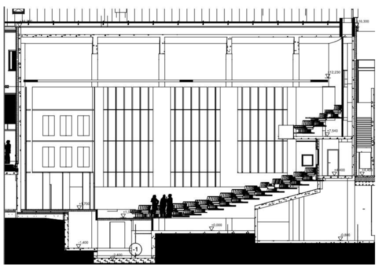


Figure 8: Length section

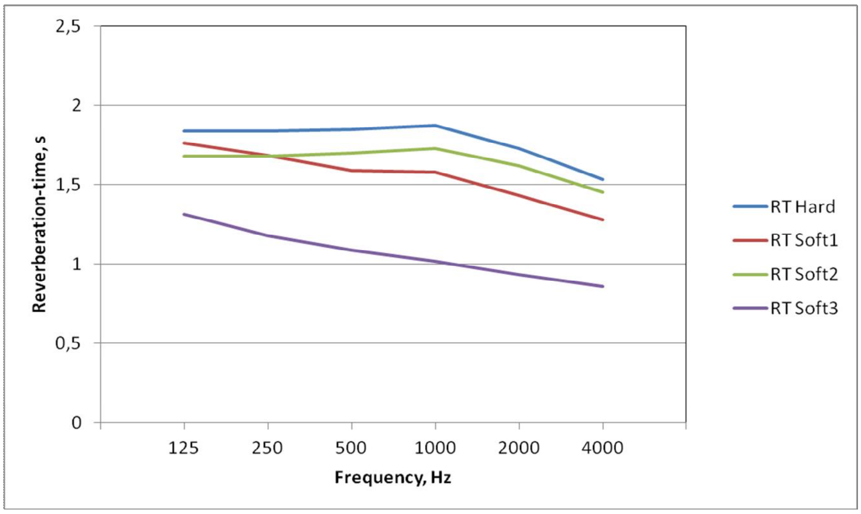


Figure 9: Measured reverberation time in the different configurations.
Soft 1: Transverse curtains only
Soft 2: Transverse curtains, side and rear wall curtains
Soft 3: All above and stage curtains

4.2 Vanaja hall, Verkatehdas Cultural Center, Hämeenlinna, Finland

The project was started by an architectural competition in 2003. In the architectural brief for the competition, a shoebox-style concert space with one or two side balconies was called for. The brief also called for a width of 17-19 m and a minimum height of 16 m., with full height in the whole space [9]. The principal uses of the hall were defined as:

- Reinforced music, including “rock” and popular music
- Classical music (acoustic music, from large symphony to recital)
- Conference
- Music theatre and opera
- Drama theatre
- Others shows and community uses, such as circus, banquets, etc.

Compared to most other Finnish cultural houses, which traditionally have been designed mainly for acoustic music, in this case it was decided that acoustics of the hall could be designed for a full orchestra as long as it did not jeopardize the other uses.

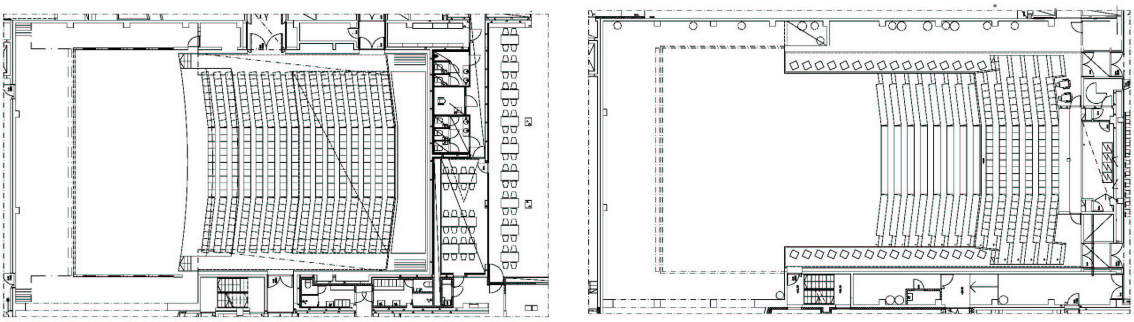


Figure 10: Plans of the Vanaja Hall, first and second floor

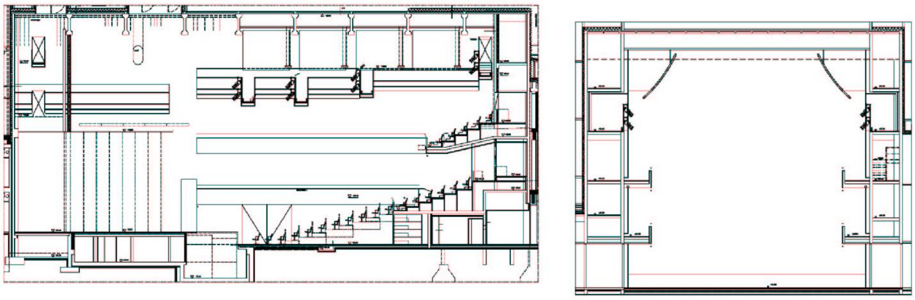


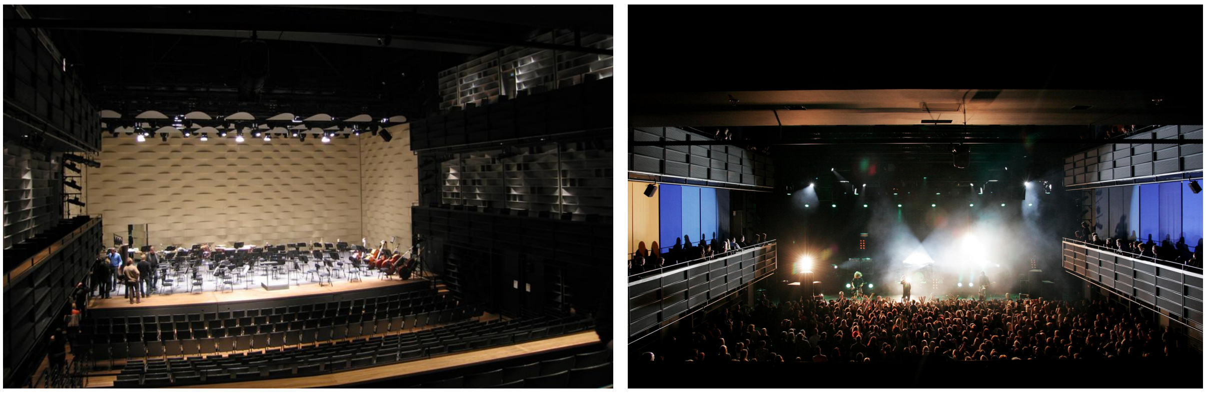
Figure 11: Length and cross section of the Vanaja Hall

The final design is basically a shoe-box with two side box balconies and rear-balcony. Furthermore there is a third technical balcony. The length of the hall is approx 34 m, the width 18 m and the height 18 m above front floor, (17 m above the stage). The stage is in normal setting 18 m wide and 9 m deep (162 m2) and can be extended by a further 4 m into the audience. The orchestra pit is 4 m deep and 14 m wide and has a nominal depth 1.4 m below the front floor.

The seating consists of 416 on the main floor with movable risers, a fixed back floor with 140 seats, four side box balconies, with 16 seats on the lower and 17 seats on the upper balconies, and a rear upper balcony with 125 seats, yielding a total count of 715 seats.

The front floor riser can be configured to an extension for the upper floor seating, as is shown in the length section in figure 11, or it can be configured to give a "half" rise with wider platforms for raised table seating, or it can be retracted to give a flat floor for banquets etc.

Both side and back wall are covered with "acoustic detailing" varying in depth from about 250 mm on the side walls and about 150 mm on the back wall. These are made of 20-30 mm MDF-boards, with an uneven surface.



Acoustic mode Reinforced mode

Figure 12: The Vanaja hall

On the upper part of the side wall, there are four reflectors on either side. These are made from multilayer gypsum boards and are curved and tilted. The fixed additional absorption is place on the wall surfaces behind these reflectors.

The variable acoustics in the audience chamber are implemented by curtains. The main curtains are four double curtains which extend from the ceiling 3 m down over the whole width of the hall. It is intended that these curtains will be the primary tools of adapting the acoustic of the hall to different performances as well as to add additional damping for rehearsals.

Furthermore there are curtains which can cover most of the side walls. These curtains are rolled down approx 100 mm in front of the wall surface and are retracted into the balcony construction when not used. The curtains are operated in several groups, which for instance will make it possible to use the lower front curtains to reduce the strength of the first reflections of the orchestra.

The stage has an acoustic enclosure with a diffusing surface similar to the structure on the side walls. The side elements are moveable, they can be parked in the backstage area. The back wall element can be hoisted, thus revealing the back and side stages. There are areas with variable absorption on the stage back wall. Furthermore the side wall elements can be moved/opened to “vent” the stage or in other words provide more absorption on the stage.

A reflector cloud of approximately 1 m^2 large elements can be hung above the stage, and can at the most cover 40-45% of the stage area. The reflectors are hung from the standard fly bars and are either stored vertically above the stage or removed and placed in storage.

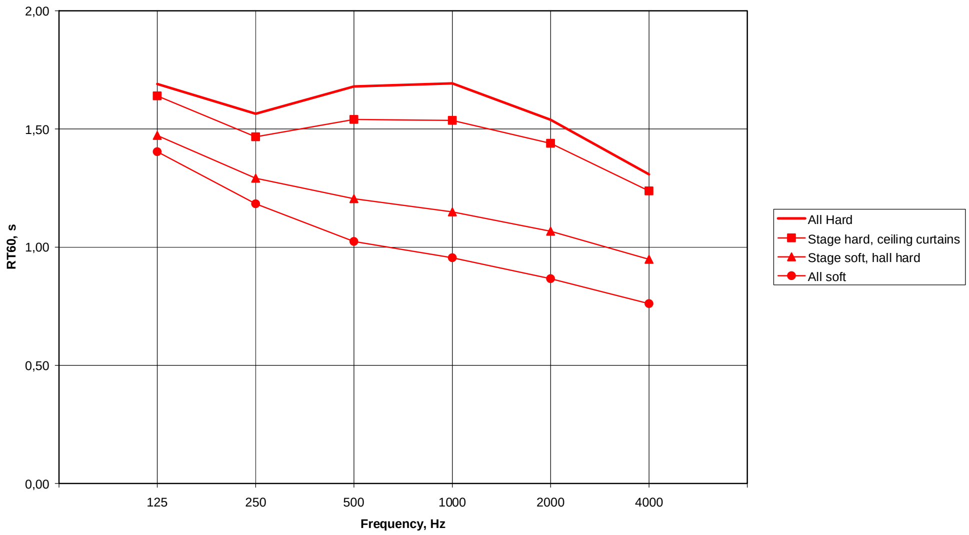


Figure 12: Measured reverberation time in the Vanaja hall for the different configurations.

5 Conclusions

This paper has shown some of the issues that needs to be attended to when building small halls which are also intended to be used for symphonic orchestras.

It is clear that it is possible to make small halls with acceptable acoustic conditions even for larger orchestras, however many of the design solutions are somewhat different from design solutions seen in normal size concert halls. It is also clear that as most of these halls are the only performance space in the community, the discussion of where to make the compromises necessary for multipurpose use, must be done at a very early stage in the project. We must remember that a performance space is a large investment and must be optimized for usability and economics.

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