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# Acoustical Design of a Conference Hall

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*Abstract:* In the building of Caras Severin County Council from Municipiul Resita, capital of Caras Severin county, in Romania, was realized an extension and modernization of space located on the first floor where we arranged a conference hall with an exhibition space in the foyer.

The beneficiary, Caras Severin County Council wanted this room to have an enviable architecture and modern technological equipment for conference and teleconference purposes, with facilities for simultaneous translation in at least two languages.

The room who have to be arranged had deficiencies between the proportions of geometric dimensions, placement of large reflecting surfaces, windows on the corners room, the poor performance of sound insulation panels on the roof, all these negatively impacting the quality sound.

The present paper refers the solutions for acoustical design (sound insulation and perception acoustics) of a conference hall, adjusted to the aesthetic demands of the architecture. We will present the acoustic specifications we would like to achieve for reasonable performances regarding the use for the space.

We opted for the acoustic environment of a diffuse field. For this purpose we used moreover for acoustic treatment the sound absorption material and sound diffuser material.

Concerted efforts of the architect, acoustic specialist and other specialists involved in planning have led to a conference hall with both architectural and modern technological equipment, with good acoustic qualities, good speech intelligibility even without electronic amplifying the sound.

*Keywords:* acoustic design, sound difussors, architecture design

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## 1. INTRODUCTION

The building of Caras Severin County Council, in Resita, dates from 1965. The building is located downtown, next the 1<sup>st</sup> of December 1918 Square, agora-city, place of entertainment and commercial center for the town. In this square, all year round, it takes place cultural activities (shows of music and theater) and also local specific feasts.

In 40 years of operation, the building has not undergone any modernization intervention, during this period all works were made only for maintenance and current repairs.

In 2006, Caras Severin County Council has initiated an extension and modernization of the building, including the conference hall and the nearby space for temporary expositions.

The room would be architectural and technological designed, to meet the requirements of European standards relating to its destination, conference and teleconference. The project was entrusted to local architect Ioana Mihaiescu.

The conference hall was supplied with high technology equipment:

- video projector containing a screen 2.5x1,9m
- video system
- three lift plasmas teleconferences
- electro acoustic system
- simultaneous translation system (two performers)
- computer network
- automation and control system

The architect, as the general designer and author of the architecture project, has created a complex group of collaborators in which was included also the acoustic specialist.

Analyzing the building plans we realized there were several areas needing deep acoustical intervention, from the point of view of sound insulation, internal acoustics and HVAC system Noise and Vibration Control.

## 2. OBJECTIVE

We defined two main objectives for this project: one to assure the necessary sound insulation to the outdoor noise; the other, concerning perception acoustics, to obtain a “non-responsive” room to

verify the acoustical conditions for a conference room as recommended.

At the same time we have to look for good acoustical conditions for speech intelligibility.

### 3. ACOUSTIC SPECIFICATIONS

The conference hall has a sole purpose of conference and teleconference hall. In most of the cases the sound is transmitted to the listeners through the electro acoustics system (complex acoustics). Rarely the hall is used without the electro acoustics system (free acoustics).

The sound source is represented by the counselor (34 persons) sited around a square table, council table, situated in the middle of the hall. The main sitting spot, on one side of the table, back sited at the projection screen, is occupied by the County's Council Chairman. The listeners (166 persons) are sited on chairs mounted on amphitheatre around the counselor's table, on the perimeter of the hall (figure 1).

The hall is situated at the first floor of the County's Council building, oriented towards the back façade. The entrance in the hall is made through a foyer, facing the city's Square. Access to the first floor is made directly from the exterior on an open spiral stair or from the interior of the building.

The foyer is a space for talk and temporary expositions.

Three walls of the room are exterior walls and the forth, interior wall, is next to the foyer.

The insulation values for the building facades and elements of facades were defined taking into account the medium values for outdoor noise levels expected as well as the maximum levels for indoor noise levels. We accepted as a specification for the project, an outdoor sound level of 45dB for a period between 22-24h. The sound levels inside the room due to electrical and mechanical systems-background noise inside the conference hall with no audience-should not overcome the sound pressure values of a reference curve NC30.

For the existing building exterior elements we specified a weighting sound reduction index  $R'_w$  not inferior to 40dB. For the existing roof we specified a weighting sound reduction index  $R'_w$  not inferior to 25dB.

In Table 1 we specified the weighting sound reduction index  $R'_w$  for the construction elements have to build.

**Table 1.** The weighting sound reduction index  $R'_w$

	Airborne sound insulation $R'_w$ dB
Building exterior walls	Min. 30dB
Room walls/foyer	Min. 40dB
Room door	Min. 40dB
Room wall/projection booth	Min. 40dB

For the interior acoustics, the reverberation time value at 500 Hz recommended for a conference hall with an average volume  $1100\text{m}^3$ ,  $RT_s$  (Sabine) is 0,85 sec. [1].

**Table 2.** Acoustic specifications of the booths for simultaneous interpretation with references to [2]

Between the booths and conference hall, $R'_w$	48 dB
Between the interpreter's booths, $R'_w$	43dB
The A-weighted Sound pressure level inside the booth	Max. 35dB(A) (NC30)
Reverberation time (booth unoccupied) $RT_{opt}$	0,3 sec
A weighted absorption coefficient of $\alpha_w$	$\geq 0,6$
Air velocity	$< 0,2\text{m/s}$

### 4. CONFERENCE HALL DETAILS

The conference hall is geometrically square shaped 16 m long and 15,5m wide and an average volume of  $1100\text{ m}^3$ .

Its seating capacity is 200 places: 166 places are for listeners distributed into rows defining an amphitheatre and 34 places are for the counselors distributed round the square council table placed in the middle of the room.

The specific volume of  $5\text{m}^3/\text{person}$  is according the specification in use.

The plan of the hall is presented in the figure 1 and the vertical section is in the figure 2.

### 5. CONSTRUCTION DETAILS

The roof of the building is metal beam construction.

Over this one is a metal structure with two 1,2 mm galvanized iron sheets filled with polystyrene panels. This structure is a weighting sound reduction index  $R'_w$  about 25dB.

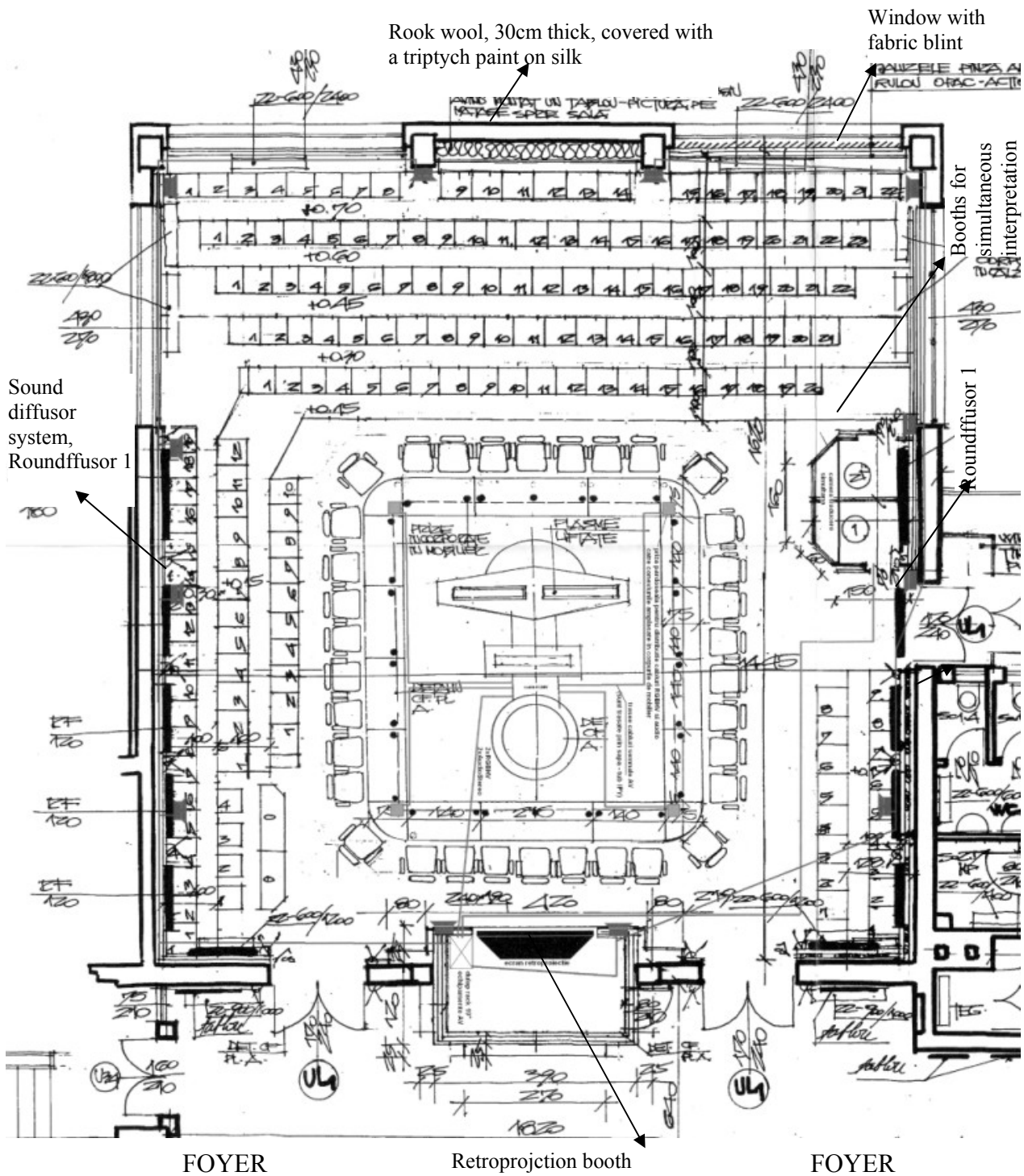


Figure 1. Plan

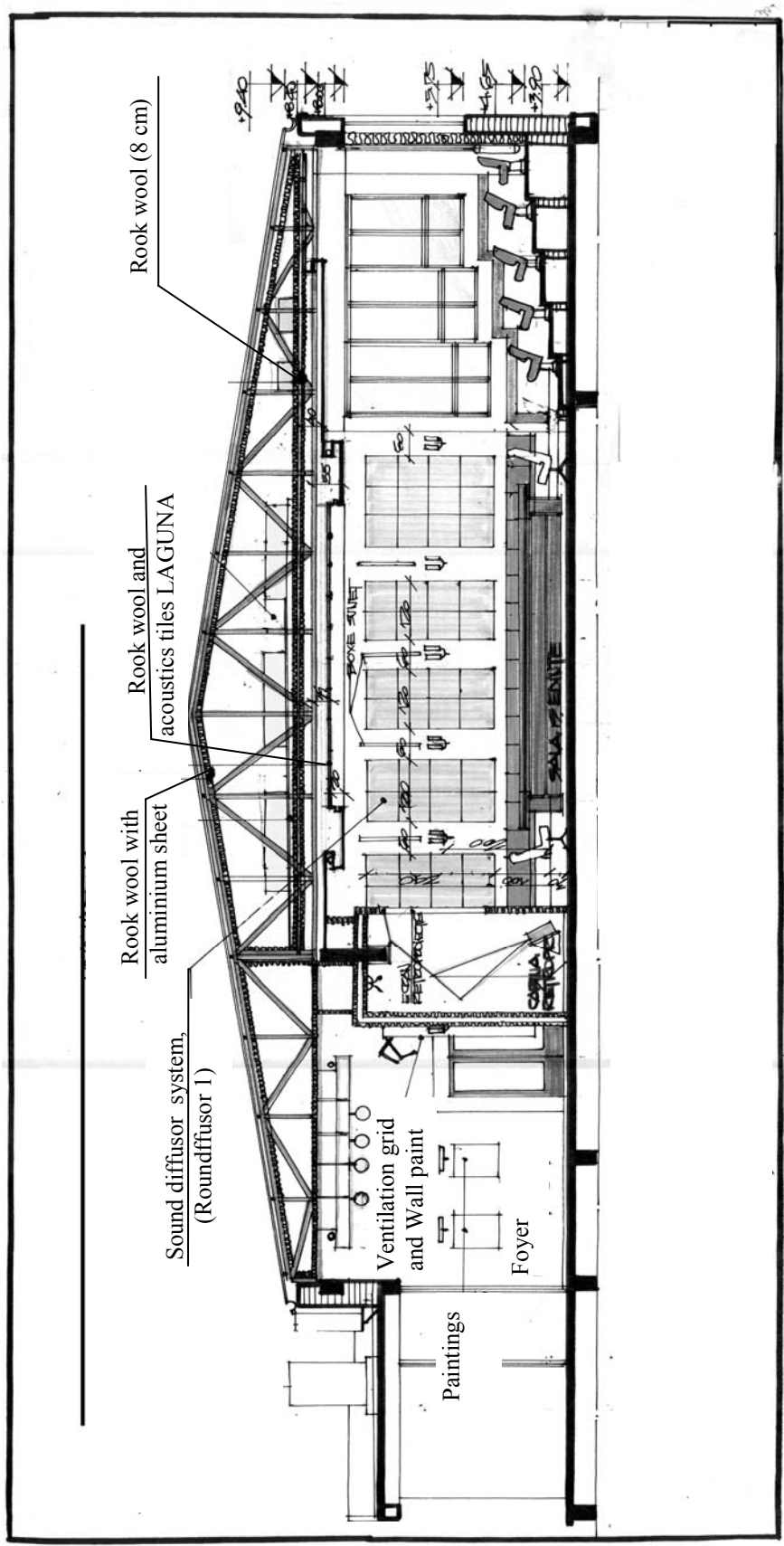


Figure 2. Vertical Section

The rock wool panels (80-90kg/m<sup>3</sup>, 100mm) with an aluminum face for thermo insulation, were directly applied under the roof.

To reinforce the sound insulation it was applied an intermediate ceiling composed of gypsum double boards, 26mm thick. Under this intermediate ceiling we applied the acoustic ceiling. We used rook wool (80kg/m<sup>3</sup>, 100mm) between intermediate ceiling and the acoustic one and between the ceiling and roofing (figure 2).

In the loft, the HVAC equipments were mounted on noise and vibration reduction system.

The acoustic ceiling is not with the floor from the point of view of internal acoustics and of the harmony between different architectural elements of the room. The acoustic ceiling is plan with Laguna tiles made by AMF-Germany.

The building exterior walls are BCA (a sort of brick) made.

For sound insulation reason, the lateral walls are lined up with gypsum panels over rook wool panels (80kg/m<sup>3</sup>, 80-100mm) and air space variable (50-100mm), total thickness about 200mm.

The recess of 300mm depth in the rear wall is filled in rock wool (50kg/m<sup>3</sup>). Perforated metal sheets are lined up over the rook wool. The visible face of this sound absorbent structure is triptych paint, on silk, made by the architecture Ioana Mihaescu.

For listeners area we used heavy carpet directly over the concrete floor and amphitheatre. For councilors area (sound source) we used wood parquet.

The two wooden folding doors are the entrance in the hall.

The lateral door is fire safe and goes out down stairs.

In the two rear comers of the hall are four big windows (4,30m x 2,80m). The big windows (42m<sup>2</sup>), built in the corners of the room, are not so good for internal acoustics.

A power diffuse sound field is my choice for solving the problems due to the geometry of the room.

So I used the sound diffusor system Roundffusor1 (R1), a new generation of sound diffusors.

Roundffusor1, a wide band sound diffuser with self regulated low frequency absorption, is the invention of Mr. Liviu Zainea, Rumanian native, who lives now in Greece. ([www.zainea.com](http://www.zainea.com))

The Roundffusor1 which is built from a complex combination of hemispheres and hemi cylinders and when grouped mounted, is simultaneously a very

active diffusor and much more complex Helmholtz resonator.

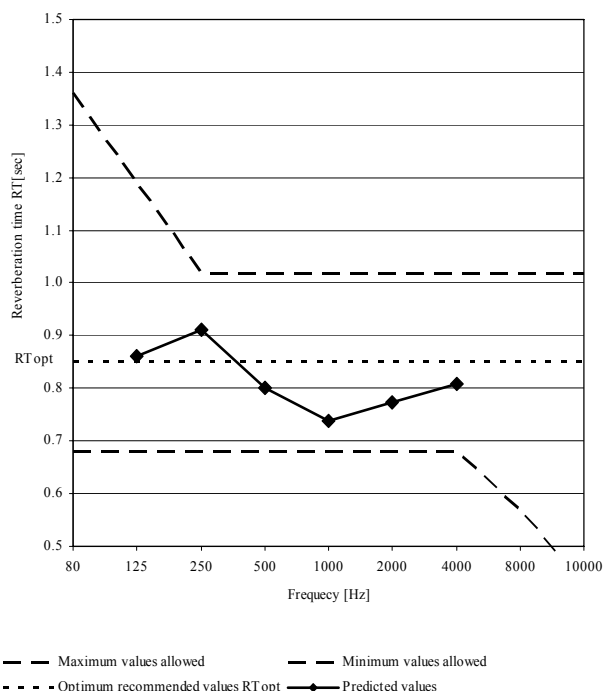
On the walls nearby the sound source, the counselor, we mounted 98 sound diffusor systems Roundffusor1 grouped in (column x line): 2x2, 2x3, 2x4 and 3x3.

The result is a powerful diffuse sound field.

In the layout of the R1 matrixes it was also take into consideration their strong visual impact due to their shape, which must have been very well controlled in order to maintain the hierarchy of the elements of the hall desired by the architect.

Between the matrixes of diffusing material were installed 12 acoustic enclosures required for the amplification of the sound.

For the conference hall, the predicted values for reverberation times RT<sub>s</sub> (Sabine) are in figure 3.



**Figure 3.** The predicted values for reverberation times RT

Inside the conference hall are placed the booths for simultaneous interpretation, designed for the weighting sound reduction index  $R'_w=48\text{dB}$ .

The booths are located at one side of the hall. It is a good visual contact between the interpreters and the sound engineer from the control panel.

Next the conference hall is retro projection booth.

It has three walls in the foyer and the forth is the conference hall wall. So the conference hall wall/retro projection booth is design for the weighting sound reduction index  $R'_w=55\text{dB}$ . The wall, 150mm thick, is composed of gypsum double boards and rook wool (80kg/m<sup>3</sup>) between the gypsum panels.

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The booth walls/foyer are design for the weighting sound reduction index  $R'_w=65\text{dB}$ . The walls, 255mm thick, are double construction of gypsum double boards and rock wool ( $80\text{kg/m}^3$ ) between the gypsum panels.

The booth ventilation is a natural one. The air comes directly from the foyer threw the grid mounted in the wall booth/foyer. From the foyer the grid it is not directly visible. The wall with the ventilation grid is seen from the foyer like big wall paint made by the local painter Nicolae Vladulescu.

## 6. CONCLUSIONS

The Hall was a difficult case because of economical limitations. The Hall was intended to be a reference for the city and the county.

For financial reasons, we didn't make the measurements in accordance with ISO 3382 to evaluate the interior acoustical conditions of the conference hall.

However the subjective impression of most participants was very positive. The participants have appreciated the acoustical perception and speech intelligibility in the room, even without the electro acoustics system.

Also the sound insulation to outdoor noise was appreciated as good.

Due to economical limitations, there are some construction elements that have not enough sound reduction indexes as it was evaluated in the acoustical project.

But we are in consideration that the background noise level inside the hall caused by 200 persons during a conference is bigger than the level from outdoor noise sources.

Finally the hall was good appreciated for its modern architectural environment, high technology equipments and, the least but not the last, good acoustic conditions.

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