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ACOUSTICS OF THE "ARSENAL" CONCERT HALL IN METZ

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Metz, a city in Eastern France, has had a very active musical life for some time, in particular through international class performances and a "contemporary" music festival. The concerts used to take place in the theater, a very dry hall. A competition was organized by the city in 1983 and 1984. The "Arsenal", an unused military building designed by Blondel, was to be transformed into a musical complex with two concert halls of 1400 and 400 seats.

As often happens, the brief for the competition assigned the future hall to symphonic music performances which would have top priority, even though dance and other events requiring a basic stage equipment could occur. Curiously, the brief required that the 1400 seats hall be divided in two halves.

The team of Ricardo Bofill, a Spanish architect, set to work in the summer of 1984 and Professor Cremer joined the acoustical consulting team. Figures 1 and 2 shows in plan and cross-section one of the early attempts of the architect at concert hall design : it was a bi-polarized fan-shaped auditorium with a transparent roof (Figures 1 and 2). The two large letters NO, drawn by Cremer, indicate clearly how this early design was rated. Before leaving the design team, since he was not able to convince the architect to alter his design, Professor Cremer suggested a solution (Figure 3) which provided two sizes, 800 and 1500, using a simple curtain to close off back rows.

Actually, the geometry of the existing building , with strong rectangular shapes turned out to be a guarantee on the basic dimensions of the future concert hall. Figures 4, 5, 6, 7 and 8 shows the final design inserted into the courtyard of the "Arsenal". The decision to bury the hall and to preserve three of the four wings of the building, froze the width (23 m) and the length of the hall. It was then only a question of negociating its depth with the fire Department to obtain an adequate volume, very close to that of the Muziekverein Goldener Saal (Figure 7).

In the competition project, the two facing tiers were identical. The cross-section was used as such to design the logo of the Music Center. Fortunately under pressure from the acoustical consultant, the main tier was enlarged and the back tier reduced as much as possible.

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Detailed acoustic design

Once the competition was over, the detailed design was performed on a 1/16 scale model which was mostly used to investigate various solutions for the ceiling elements which would provide adequate reflections to the main tier and good ensemble conditions to the musicians but, mostly, early reflections to the back tier. This was later checked on the SoundBase computer modelling programme.

The wooden diffusers of the ceiling have various shapes (Figures 9 and 10). Some are concave, in particular above the stage, and others are convex. The adequate mix was actually finalized on the scale model.

The installation of diffusing elements at about ten meters above the stage had been included in the project, to obtain improved ensemble conditions, but these elements have not been required. Reflections from the ceiling diffusors and of the lateral diffusors seem adequate in most cases.

The architect insisted at first on perfectly flat lateral walls which would have made it impossible to play music in the hall. Since this architect usually places fake columns as his "trademark" in all of his building, it was easy to convince him to add columns in the stage area for diffusion

The main material in the hall is wood :

- Ceiling : plaster with wooden diffusers
- Floor : wood on sleepers with resilient elements
- Walls : wood panels and columns with damped air space of varying depths

To obtain the mellow acoustic response which was wished, several types of wood panelling constructions have been distributed throughout the hall (Figure 11). The thickness of the panels, as well as the depth of the cavities behind them, and the damping all vary.

The hall is surrounded by a gallery : to avoid harmful coupling between the hall and this relatively large volume, it was made diffusing and absorptive, a choice tested on the models which turned out to be the right one.

The detailed characteristics of the hall are provided in Table I.

The goal was to obtain a reverberation time of 1.9 secondes over the widest possible frequency range, a clear sound and a smooth diffused field. The measurements (Figure 12) with and without an audience show that it is not quite the case. The problem occured when the architect, ill-advised, refused the seats which had been approved by the acoustical consultants. He insisted on having stainless steel and leather seats, which somehow look like an earlier Mies van der Rohe famous design and which are not acoustically sound when unoccupied.

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As a result, the hall does not have an adequate response for rehearsals in the empty room and does not have the exact acoustical character that the designers had wished during concerts. Fortunately, the Orchestre Philarmonique de Lorraine has patiently gotten adjusted to this condition. Obviously, the seats will have to be replaced at some point and this question can then be solved.

To be complete, it should be added that when rock and amplified jazz concerts have been held, the hall turned out to be inadequate, which was not a surprise for the designers.

However, for classical concerts, from recitals to symphonies, it has been well received by musicians and concert go-ers and musical activity in the City of Metz has been flourishing since the opening of the hall.

Table I.

A summary of the main characteristics of the "Arsenal"

Volume		: 13605 m3
Depth		: 17.50 m
Length		: 54.00 m
Furthest row		: 33.00 m from conductor
Width		: 23.00 m
Number of seats	Total	: 1548
	Main tier	: 891
	Back tier	: 429
	Sides	: 228
Ceiling diffusers		: 65 (Sycomore, 4 cm)
Cost		: FRF 120 000 000 (1989)
Project		: 1984
Construction		: 1987-1989

ACOUSTICS OF THE "ARSENAL" CONCERT HALL IN METZ

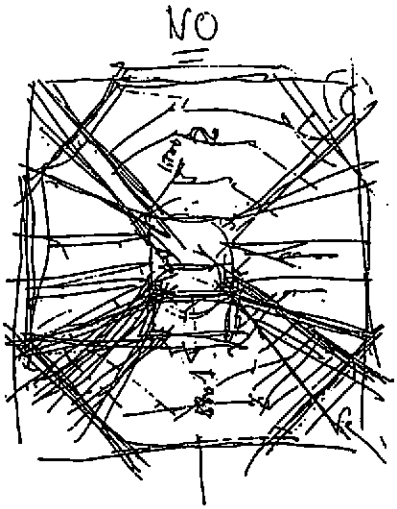

Figure 1. : Early design of a double fan-shaped auditorium (plan)

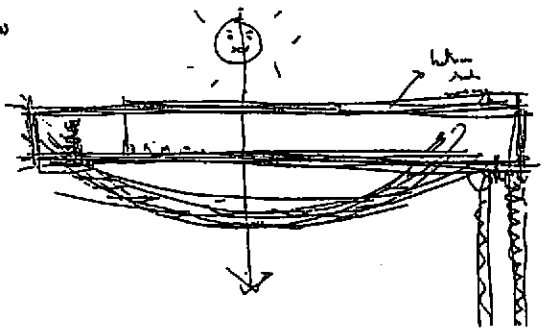

Figure 2. : Architect's cross-section with transparent roof

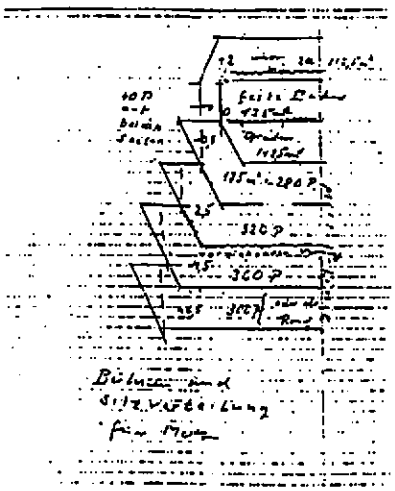

Figure 3. : Cremer's "weinbergen" solution

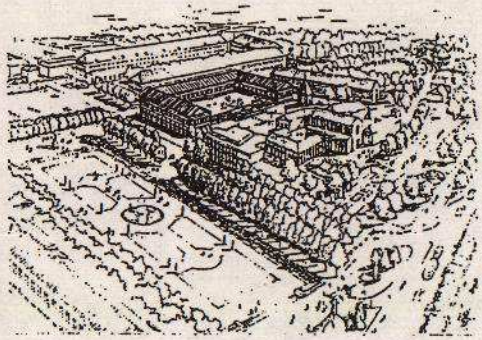

Figure 4. : A view of the completed building : the concert hall is buried under the courtyard of the former ammunition depot.

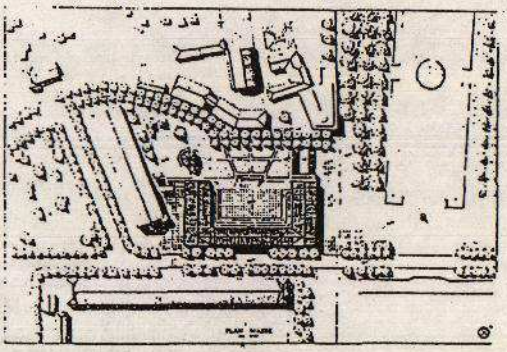

Figure 5. : Plan of final building

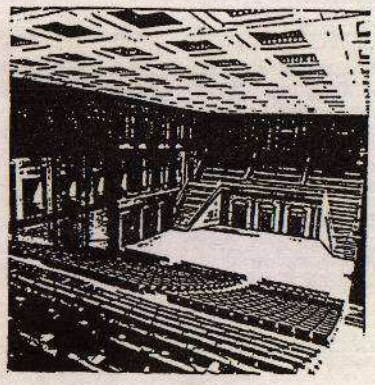

Figure 6. : View of the "Arsenal" from the back row

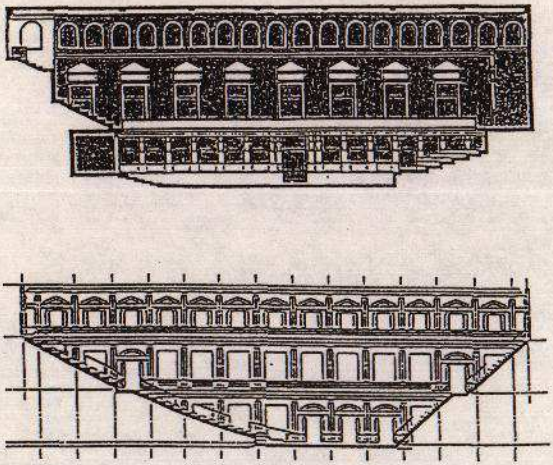

Figure 7. : Cross-section of the bi-polar concert hall :
Top : Muziekverein
Bottom : Arsenal
(identical scales)

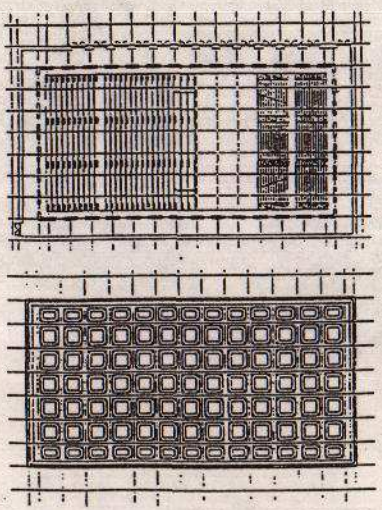

Figure 8. : Floor and ceiling plans

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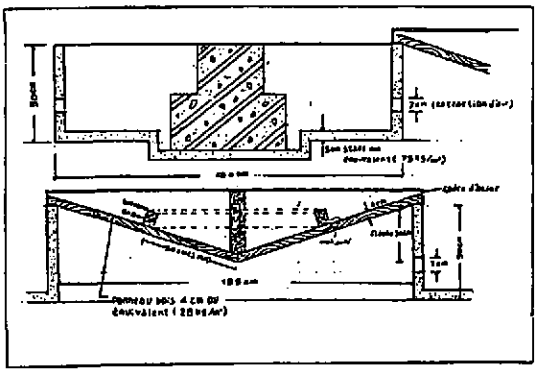


Figure 9. : Typical cross-section of the plaster and wood ceiling diffusing elements

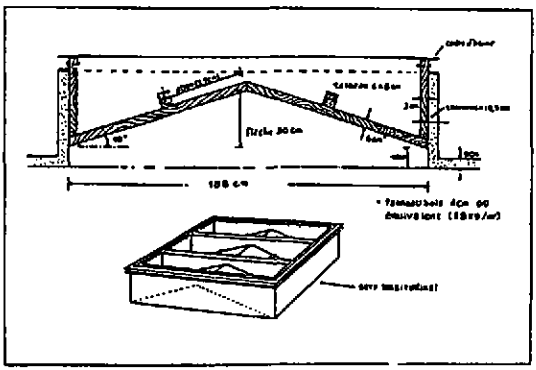


Figure 10. : Typical cross-section of the diffusing elements above the stage

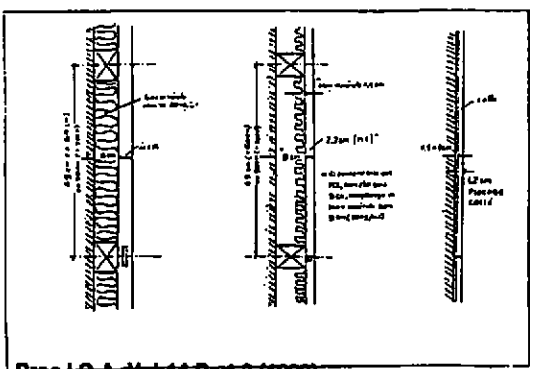
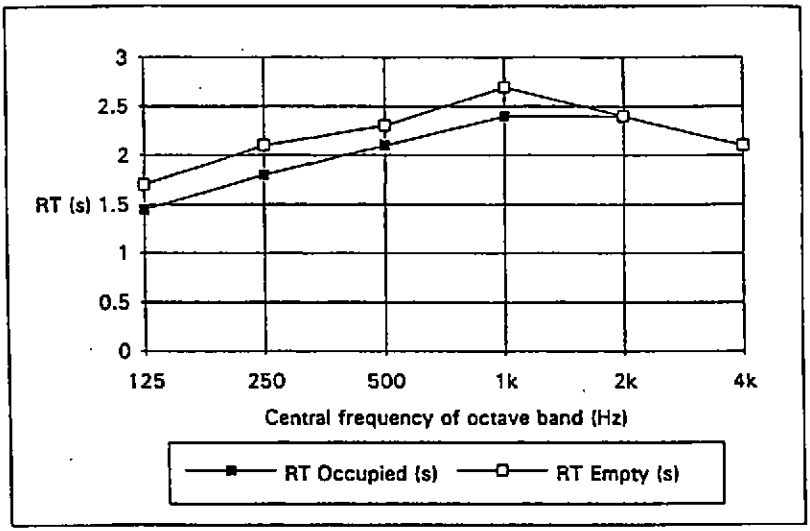


Figure 11. : Typical panel system



F(Hetz)	125	250	500	1k	2k	4k
RT Occupied (s)	1.45	1.8	2.1	2.4	2.4	2.1
RT Empty (s)	1.7	2.1	2.3	2.7	2.4	2.1

Figure 12. : Reverberation time in the "Arsenal"