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Introduction

Performing-arts complexes increasingly rely on a pair of auditoria—a compact room for spoken word and chamber ensembles, and a larger space for symphonic repertoire—to cover the full spectrum of programming. Vatroslav Lisinski Concert Centre in Zagreb is an instructive example of such facility, it houses 1,840-seat Large Hall and a 304-seat Small Hall. Both spaces share timber interior finishes, variable drapery, and a common technical backbone, yet they differ in geometry, stage configuration, and the distance between listeners and reflective surfaces.



Figure 1: Interior view of the small hall of the Vatroslav Lisinski Small Concert Hall, Zagreb.

The present study records ISO 3382-1 parameters in both halls. It explores how differences in volume, plan form, and surface treatment account for the measured divergence and considers the implications for incremental acoustic upgrades.

History and architecture

The Vatroslav Lisinski Concert Hall was designed by a group of architects, Marijan Haberle, Minka Jurković, and Tanja Zdovalak, and construction started in 1961. The hall is named after Vatroslav Lisinski, the composer of the first Croatian opera. The Small Hall has 309 seats. It has become an essential part of this Croatian temple of music. A view of the concert hall is shown in Figure 1.

The Small Hall (Mala dvorana) occupies the eastern wing of the Vatroslav Lisinski complex. The stage is framed by splayed timber side walls that improve early lateral reflections.

Seating consists of upholstered chairs fixed to loose timber bases. The ceiling presents a discontinuous canopy of colored gypsum panels is suspended beneath the structural slab.

A low-profile technical gallery allows reverberation to be trimmed for spoken-word or amplified events.

Description	Features
Type of plan layout	asymmetric fan shape
Total capacity	305 max.
Volume	2,000 m ³
Floor area	330 m ²
Main Hall axes	19.8 × 17 m
Stage dimension	12 × 7.5 m
Inclination of stalls	4%

Table 1: Architectural features of Lisinski Small Concert Hall

Experiments

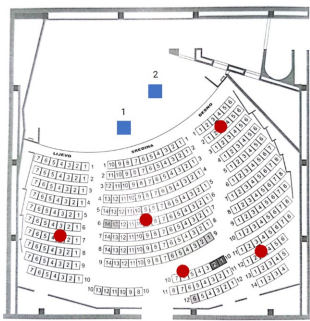


Figure 2: Position of the source and receiver during the measurements.

To evaluate the room response, an acoustic measurement campaign was conducted using the following equipment:

- Equalised omnidirectional loudspeaker Look Line
- Binaural dummy head – Neumann KU-100
- B-Format – Sennheiser Ambeo
- Omnidirectional microphone – Brüel&Kjaer
- 64-channel spherical array MH Acoustic em64 Eigenmike®



Figure 3: Position of the source and receiver during the measurements.

Measurements were conducted in an unoccupied hall, with the apparatus positioned at several predefined points as illustrated in Figure 2.

The source loudspeaker was placed 1.5m above the stage floor, and the receivers were set at 1.2 m to match the average ear height of seated listeners. An exponential sine sweep (ESS) lasting 15s, with a frequency range from 40 Hz to 20 kHz, served as the excitation signal. The source and receiver equipment are shown in Figure 4.

Results

The recorded impulse responses were processed and analysed to extract monaural and binaural acoustic parameters in accordance with ISO 3382-1. Results are averaged across all receiver positions and presented as two curves: VLS for the Lisinski Small Hall and VLL for the Lisinski Large Hall. Figures that follow summarise the measured results in the frequency domain comprised between 125 Hz and 4 kHz.

Reverberation time

Figure 3 demonstrates that VLS exhibits a compact and well-controlled early decay: EDT rises from 1.1s at 125Hz to a broad maximum of 1.55s at 2kHz, then falls slightly to 1.4s at 4 kHz. For reference, VLL traces an almost parallel trend but sits 0.4–0.6s higher across all bands.

The same hierarchy appears in T30 (Figure 4). In VLL, the curve is shifted upward, 1.9s at 125 Hz to 2.2 s around 1 kHz indicating the longer residual energy. Overall, the data shows that the Small Hall provides the shorter decay and tighter clarity needed for recitals, conferences, and amplified speech, while the Large Hall retains the extended reverberation that gives full-orchestra repertoire the desired warmth.

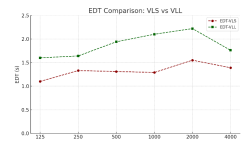


Figure 3: Measured results of Early Decay Time (EDT)

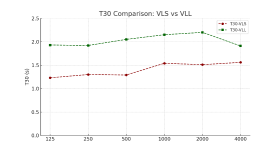


Figure 4: Measured results of Reverberation Time (T30)

Clarity index

Figure 5 reports that Small Hall (VLS) keeps C50 within -2 dB to +0 dB across the spectrum, satisfying guideline for unamplified speech while the Large Hall (VLL) lies 1–2 dB lower at every octave. The advantage in VLS stems from its smaller volume and closer side-wall distances, which raise the proportion of early energy reaching the listener.

Music clarity (C80) in Figure 6 shows an even larger gap. VLS ranges from +2.7 dB at 125 Hz to roughly +1 dB at 4 kHz, values that provide good note definition without excessive brightness. VLL remains a level suited to orchestral blend.

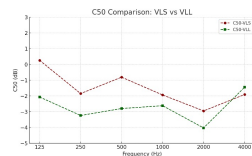


Figure 5: Measured results of speech clarity (C50)

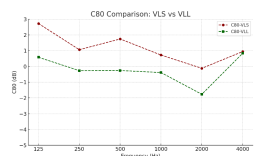


Figure 6: Measured results of music Clarity (C80)

Definition and Inter-Aural Cross-Correlation

VLS provides the stronger early-energy ratio. D50 is stable and averaged around 0.41, value that exceed those of VLL by 0.05–0.08. Both rooms stay above the 0.30 intelligibility threshold throughout the spectrum, but only VLS approaches the 0.50 target regarded as “excellent” for unamplified speech.

Inter-aural cross-correlation falls more sharply in the Small Hall. The 0.10–0.15 offset indicates that early lateral reflections are stronger and arrive sooner in VLS producing a broader sense of spatial envelopment. In the larger room, a narrower stereo image is recorded. The sample curves are shown in Figure 8.

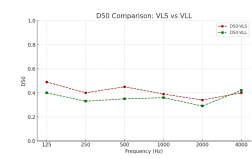


Figure 7: Measured results of Definition (D50)

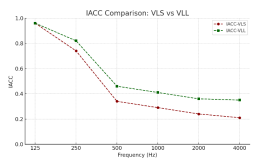


Figure 8: Measured results of Interaural Cross-Correlation (IACC)

Conclusions

The survey confirms that the Small Hall at Vatroslav Lisinski delivers a compact acoustic response tailored to recitals, chamber ensembles, and spoken-word events.

Comparison highlights that the larger volume trades intelligibility for the warmth valued in full orchestra repertoire while the small one enhance articulation and sense of intimacy. Together, the two venues offer the venue operator a balanced programme capacity ranging from amplified lectures to symphonic concerts.

Limited, targeted adjustments would further widen the usable range without compromising the acoustic identity of either space.

Acknowledgement

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