Roomacoustical Conditions for the Landau Festival Hall, Germany

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1 Introduction

The 1041 seat concert hall has been totally rebuilt during the last years and was reopened on February 12, 2003 with a concert of the Rheinland Pfalz Philharmonic Orchestra. The great evening was another milestone in the long history of the hall, once again in the glamour of former "Jugenstil" when the hall was built in 1907/1908. In 1952, Furtwängler conducted the Berlin Philharmonic Orchestra and was enthusiastic about the great acoustics of this old hall with 2000 listeners in the audience. But, in these days the Jugendstil as Art Nouveau was no longer acceptable /1/ although Jugendstil was a great movement from 1900 on. Originally it was the pep and verve of the youth to follow their feelings and intentions freely, e.g. towards many ornamentations in architecture. The Jugenstil did no longer match the strong and straight lines of the 50's. A new age had begun leaving back many old traditions. Scientific work started at universities and in companies. Schools were founded, such as by Hermann Scherchen in Gravisano /2/3/. Direct sound, sound reflections and reverberation had to be studied /4/. The "Feinstruktur des Schalles " (Precise structure of sound) became well known. At this time in 1958, H. Weisse became acoustical consultant for the Festhalle in Landau. The Newspaper Rheinpfalz wrote on February 24, 1958 quoting an expert: The acoustics of the old Jugenstil Hall were bad. The hall would be insufficient for all other events, except for the great sound of a big sinfony orchestra in a concert including 2000 people. Weisse knew that a reduction of reverberation time was necessary, e.g. for the hall when partly occupied, for Theater or for the use of a sound reinforcement system. He predicted a reverberation time of 1,45s /5/ while the audience still prefered the acoustics of the Großer Saal of the Wiener Musikverein (Vienna Concert Hall) with a reverberation time of 2,0s /5/ or of the Berlin Philharmonic Hall with 1,86s /6/. Measurements in 1998 when the reconstruction began, led to only 1,16s unoccupied, and around 1s occupied.

What is now the best way back to Jugendstil? How was the hall when Furtwängler said: Great acoustics? Why this change in the 50's? What was wrong before? Was it the huge amount of mortar structured as a comb, what made the hall sound blunt? Should the hall be reconstructed only to receive the label "bad hall"?

2 Reverberation times

The old Jugendstil Hall was with 2000 unoccupied wooden chairs rich of reverberation, as assumed in Fig.1 with curve 7 of around 3s. Völker found a compromise in March 2000, predicting 1,5s as in curve 3 /7/. The curves 1 and 2 show the difference between empty and occupied hall during opening in January 2002 with 1,44s/1,66s

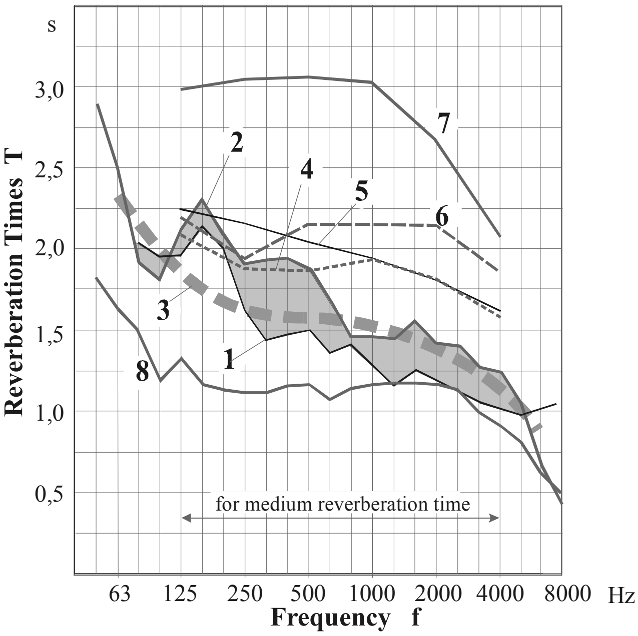

Fig.1 Reverberation Times of Landau Festival Hall

1	Opening concert on 2002-01-12, 1041 seats, 60 musicians pit covered for additional seats, V=6900m³	Tm=1,44s
2	Hall unoccupied	Tm=1,66s
3	Proposed in March 2000	Tm=1,51s
4	Berlin Philharmonic Hall /10/ occupied 2325 seats	Tm=1,86s
5	Vienna Vereinsmusiksaal /10/ occupied 1680 seats, V=15000m³	Tm=1,98s
6	as 4, unoccupied	Tm=2,08s
7	as 5, unoccupied	Tm=2,81s
8	Measurement on 1998-01-13, V=6230m³ unoccupied, stage open, no window curtains 923 concert chairs	Tm=1,16s
	Curves 4-7 in accordance with Beranek 1966	

3 Warmth and Brilliance

The longer the reverberation times are at low frequencies the warmer the hall sounds within the ratio and best values of 1,10 und 1,25 according to Beranek /8/. RTs should therefore be long enough at low frequencies to obtain this sound in the hall. Landau has 1,21 /Berlin Philharmonic Hall 1,03 /Multipurpose Hall in Oberursel /9/ 1,13 and Pfälzische Philharmonie Ludwigshafen /10/ 1,00. Brilliance is the opposite. A room sounds brilliant when the RTs are longer at high frequencies. Shorter RTs at high frequencies are usually due to many sound absorbing areas, curtains and boxes. Many sound reflections and therefore, a longer RT at high frequencies of 2000 to 4000 Hz means the hall sounds bright and brilliant. Instead, the Vienna Vereinsmusiksaal has unoccupied only 0,77. In Landau it was attempted to avoid a strong roll-off at high frequencies. The ratio of 0,85 indicates the hall is near avarage.

4 Clarity

Clarity is defined as the ratio of early to late sound energy of reflections /8/. Clarity is easy to judge. The audience usually prefers being bathed in sound with more late reverberant reflections equivalent to C-values of -1 to -4. For theater however a bigger C is required from 1 to 4. The Festival Hall has reached the estimated figures. The back part of the balcony had to be provided with direct sound and comparably only small lateral energy. This is essential for speech. The balcony and the back part of the parquet have a good clarity of 1,8. Third row much less: -0,55 which is comparable to e.g. Berlin Philharmonic Hall. Orchestra rehearsals do not need a large C. Instead, room impression is desired. This is equal to late arriving reflections if possible later than 80ms.

5 Speech Intelligibility

A compromise had to be found between concerts and theater. Did the values reach this goal?

* RT equal to approx. 1,4s
* SPL high, with useful reflections
* Clarity high, >1, approx. 1,8 dB
* Warmth good with 1,21
* Brilliance good with 0,85

This is typicaly both good and less good for speech. Warmth should be smaller with a shorter RT at low frequencies. Brilliance should be smaler with less late reflections and shorter RT. Therefore the STI (Speech Transmission Index) differs between 0,57 to 0,74 from fair to good /11/.

6 Acoustic-Sails

The newspaper Rheinpfalz wrote on 2002-05-27, five month after the opening: “With the acoustic-sails a great sound is reached. Musicians are enthusiastic about the good acoustics. Theater artists are content with the intelligibility of sound.” Many acoustical reasons led to this conclusion. First, the lack of first reflections along the side balconies. This was found by model investigations with the scale of 1:15 using laser rays and mirrors /12/. Second, the balcony is partly far back at 33m. How can the listeners be reached? Only by directing the sound using reflectors in the right shape. Thirdly, more early reflections should arrive in the middle of the parquet. Disadvantages can easily occure when strongly directed sound leads to echos. One can make use of a trick to avaoid this: Take many early reflections to mask out the echo. Therefore, from the beginning on many small or larger reflecting surfaces had to be found /13/ with the advantage of receiving a good feedback as an answer from the room.

7 Energy-Time-Curves

An omni-directional microphone receives at the listeners place both the direct sound and the later arriving reflections. The measurement technique is based on TEF technology measuring in the Time, Energy, and Frequency domain /14/12/. The result is an energy time curve as a room response or impulse response when an omni-directional loudspeaker on the stage irradiates sound into the hall, see Fig. 2. From zero to e.g. 80ms, direct sound and first reflections have arrived as direct sound and lateral reflections as coming from the stage and the side walls.

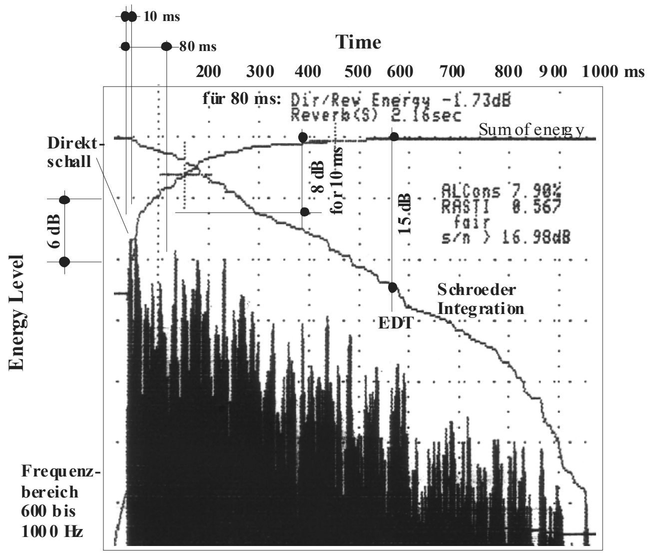

Fig 2 TEF Reflectogram with energy ratios, reverberation times, STI and Schroeder Integration

Many roomacoustical properties can be derived from the ETC, e.g.: 10ms for lateral Index acc. to Kuhl (1978), 50ms for D as Deutlichkeit acc. to Thiele (1953), 80ms for C as clarity acc. to Reichardt (1975)

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