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ABSORPTION AREA MATTERS
IN SYMPHONY ORCHESTRA REHEARSAL ROOMS
Outline

- Problem
- Data collection - method
- Analysis
- Suggestions, Recommendation
- Discussion
Google-it: «Orchestra Rehearsal Room
Problem

- **Wanted:**
  - Rehearsal spaces for symphony orchestras
  - Adequate acoustics – recommendations
  - ISO-standard currently in the making
  - Limits in T-V diagram
  - Data from existing rehearsal rooms
  - Ratings, as a basis for limits
Data collection, sources

- Literature review
- Papers, articles, reports
- Invitation to submit data – [www.akutek.info](http://www.akutek.info)
- Personal communication with acousticians
$T-V$ data collected, 37 rehearsal halls

Rehearsal spaces for symphony orchestras (unoccupied)

- $y = 0.9 \lg(V) - 1.8$
- $R^2 = 0.27$

Graph showing data points and lines for various criteria and a logarithmic fit.
Small $< 6500\text{m}^3 < \text{Big}$

Small $V < 6500\text{m}^3$
Big variation $0.7-1.9\text{s}$

Big $V > 6500\text{m}^3$
Small variation $1.8-2.0\text{s}$

$y = 0.9\lg(V) - 1.8$
$R^2 = 0.27$
38%, 13 out of 37 cases with ‘issues’
Absorption area suggestion $A > 560 \text{ m}^2\text{Sa}$

Gade (2012): 8 m$^2$Sa per musician
assume $>70$ musicians
$70 \times 8 = 560$

'issues' above limit $1/12 = 8\%$

'issues' below limit $13/25 = 52\%$
Typical symphony orchestra layout
Odeon-models with average $D-R = 0 \text{ dB}$

7 models
Same 90p orchestra
All average $D-R=0$

<table>
<thead>
<tr>
<th>$V$ (m$^3$)</th>
<th>$T_m$ (s)</th>
<th>$D-R$ (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.62</td>
<td>0.0</td>
</tr>
<tr>
<td>2500</td>
<td>0.88</td>
<td>-0.1</td>
</tr>
<tr>
<td>3150</td>
<td>0.95</td>
<td>0.0</td>
</tr>
<tr>
<td>4000</td>
<td>1.17</td>
<td>-0.1</td>
</tr>
<tr>
<td>5000</td>
<td>1.44</td>
<td>0.0</td>
</tr>
<tr>
<td>6300</td>
<td>1.58</td>
<td>0.1</td>
</tr>
<tr>
<td>8000</td>
<td>2.09</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Grid response
$V = 5000 \text{ m}^3$
$T = 1.44\text{s}$ (unoccupied)
$D-R = 0.0 \text{ dB}$
Limits mapped to $T-V$ diagram

Note: Limits are practically equivalent

- **no issues**
- **issues**
- **NS low**
- **NS high**
- **ISO low ??**
- **ISO high ??**
- **560m2Sa**
- **D-R=0**

(D-R average over 90p orchestra)
Interpretation of suggested limits

- Direct-Reverb-Balance constant
- Acoustic Transparency constant
  - Reverberation Radius constant
- Mutual Hearing constant
- Ensemble Blend constant
- Possible effects
  - Blend vs Transparency adequately balanced
  - Counteract forced playing and escalating sound levels
  - Happier musicians and conductor
Transparency – optical analogy
Comments

- $A > 560$, a basic necessity, but not always sufficient
  - early reflections must be considered (early masking, etc.)
- Simulated $D-R = 0$ is a more complete criterion
  - takes energy-time distribution into account
  - requires a 3D-model simulation tool
Summary

- T-V data from 37 SO rehearsal rooms
- $V<6500m^3$, wide T-span, $T = 0.7-1.9s$
- $V>6500m^3$, T like in concert halls $T = 1.8 -2.0s$
- A-limit accepting ‘Issues’ in 8% $A > 560m^2Sa$
- Gade (2012), 8m2/p example $70p*8m2Sa = 560m2Sa$
- Inter-orchestral direct-reverb, average $D-R = 0 dB$

Keywords

- Acoustic Transparency
- Direct-Reverb-Balance
- Reverb Radius,
- Mutual hearing
- Ensemble
- Counteract forced playing and escalating sound levels
- Happier musicians and conductor

- More data welcome
Thank you


More info?

The www center for search, research and open sources in acoustics

www.akutek.info

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Transparent (direct) and blended (reverberant) sound to conductor’s ears; Reverberation radius $r_r$ and level $G_r$

$G_r = 4\, \text{dB}$

$G_r = 7\, \text{dB}$

$G_r = 10\, \text{dB}$