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Improving the Visitor Experience: A Noise Study and Treatment Design for the Smithsonian's National Zoological Park Great Ape House

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Improving the Visitor Experience:
A noise study and treatment design for the Smithsonian’s National Zoological Park Great Ape House

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What’s the Problem?
What’s the Problem?

\[ \approx 2 \text{ Million visitors each year} \]

\[ = \]

Lots of noise in a very reflective space

\[ = \]

Difficult to hear conversations and fatiguing to the volunteers & staff
Process

Step 1: Baseline Measurements

Step 2: Design & Apply Treatment

Step 3: Final Measurements
Baseline Measurement: RT

Impulsive Measurement

Multiple Locations

Reverberation Time (space averaged)

1/3 Octave Band, [Hz]
What is the noise problem?
24/7 for 7 weeks
A-weighted Equivalent Level
Un-weighted Equivalent Levels in 1/3 Octave Bands
What is the noise problem?

24/7 for 7 weeks

A-weighted Equivalent Level

Un-weighted Equivalent Levels in 1/3 Octave Bands
Baseline Measurement: Sound Level

What is the noise problem?

24/7 for 7 weeks

A-weighted Equivalent Level

Un-weighted Equivalent Levels in 1/3 Octave Bands

Average Over Time: Un-Weighted Equivalent Level Spectra

- All Times
- Exhibit Closed
- Exhibit Open
- 10 Loudest Intervals
Baseline Measurement: Sound Level

What is the noise problem?

24/7 for 7 weeks

A-weighted Equivalent Level

Un-weighted Equivalent Levels in 1/3 Octave Bands

Average Over Time: Un-Weighted Equivalent Level Spectra

1/3 Octave Band Frequency, [Hz]
Micro-perforated film in a modular, tile-based design

Exhibit-friendly

Excellent absorption performance

![Graph showing absorption coefficient vs. octave band center frequency (Hz)]
<table>
<thead>
<tr>
<th>Material</th>
<th>Area, ft²</th>
<th>Area, m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum Board</td>
<td>4183</td>
<td>389</td>
</tr>
<tr>
<td>Plastic</td>
<td>557</td>
<td>52</td>
</tr>
<tr>
<td>Concrete</td>
<td>2235</td>
<td>208</td>
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<tr>
<td>Brick</td>
<td>2804</td>
<td>260</td>
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<tr>
<td>Glass</td>
<td>2610</td>
<td>242</td>
</tr>
<tr>
<td>Dirt</td>
<td>479</td>
<td>44</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>12867</strong></td>
<td><strong>1195</strong></td>
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</tbody>
</table>

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<tr>
<th>Volume:</th>
<th>ft³</th>
<th>m³</th>
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<tbody>
<tr>
<td></td>
<td>62318</td>
<td>1765</td>
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</table>
\[ RT = 0.161 \frac{V}{A} \]

RT = Reverberation Time, [s]
V = Volume of the Space, [m^3]
A = Absorption, [Metric Sabins]

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Room Model

Predicted Reverberation Time: Baseline and Treated

Reverberation Time, [s]

Octave Band Frequency, [Hz]
After-Treatment Measurement: RT

67 m² (720 ft²) of tiles were installed over concrete sections of the walls.

Good Agreement Between Predictions & Measurements

RT: Prediction vs. Measured - Post Treatment

- Model Prediction
- Measurement
Conclusions

Lots of Visitors = Lots of Noise

Rev. Time & SPL measurements to quantify the problem

Model of the room to predict the improvement from various treatment designs

Modular, micro-perforated treatment provided good absorption performance

Reduction in Rev. Time of approximately 1 second

Positive feedback from Zoo staff thus far
Future Work

1. Measure SPL over time, same as before, for the treated room.
2. Investigate improvements to speech intelligibility due to the increased absorption in the space.
3. Use continued measurements along with visitor and staff feedback to determine if more treatment is necessary.
Thank you!

Any questions?