

Summary of NEST+m Low-Cost Auditorium Acoustics Solution

Cooper Union Independent Study Project

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Figure 1 View from Left End Corner



Figure 2 View from Stage

Background

NEST+m, New Explorations into Science, Technology + Math, is a K-12 public school located in the Lower East Side of New York City. The NEST+m auditorium is fan-shaped with a volume of 100,000 ft³ (about 2900 m³) and 529 seats. This auditorium's acoustics is relatively poor due to its high reverberation time making the clarity of speech very low.

Project Description

This project seeks a low-cost solution for reducing the reverberation time while also engaging the schools' students in a creative and interactive project. The NEST+m students can learn about the basic knowledge of auditorium acoustics, and engage in a hands-on, creative project by decorating their auditorium with the proposed acoustic panels. The panels can be detachable and removed when more reverberation is desired, for example, during concerts.

Project Calculations and Assumptions

The calculations for this project are mostly based on Sabine's formula, which correlates the reverberation time, i.e., the time for sound to decay by 60 dB (RT_{60}), of the room, its volume, V , and its total absorption area, A (in sabins):

$$RT_{60} = 0.161V/A$$

Where the absorption area, A , can be calculated from the material absorption coefficient, a , and its surface area, s , using the equation below:

$$A = s_1a_1 + s_2a_2 + \dots + s_na_n$$

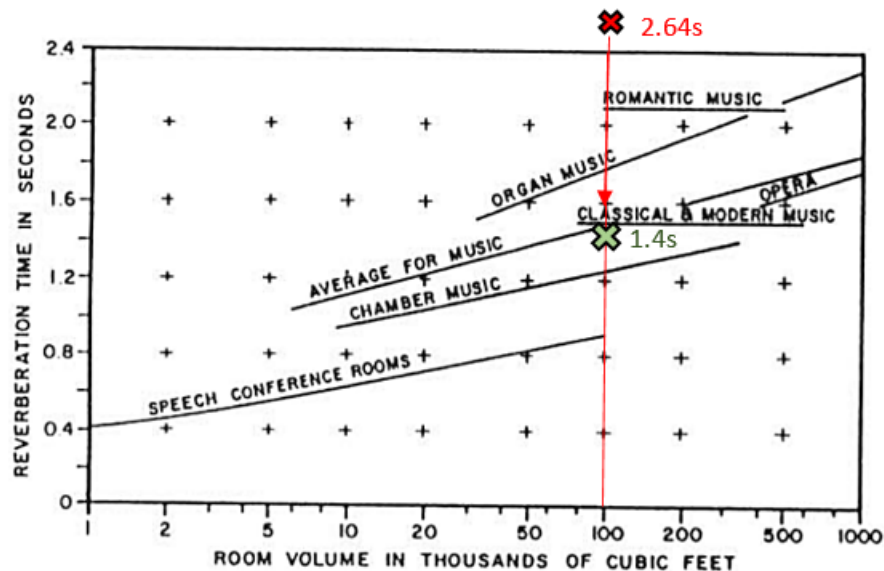
The panels specified for the calculations are Knauf Black Acoustical Boards (2-inch-thick, 3.0PCF) and the absorption data is below.

Black Acoustical Board Sound Absorption Coefficients								
Octave Band Center Frequency (Hz)								
Density	Thickness	125	250	500	1000	2000	4000	NRC
3.0 PCF (48kg/m ³)	2" (51mm)	0.33	0.67	1.07	1.07	1.03	1.06	0.95

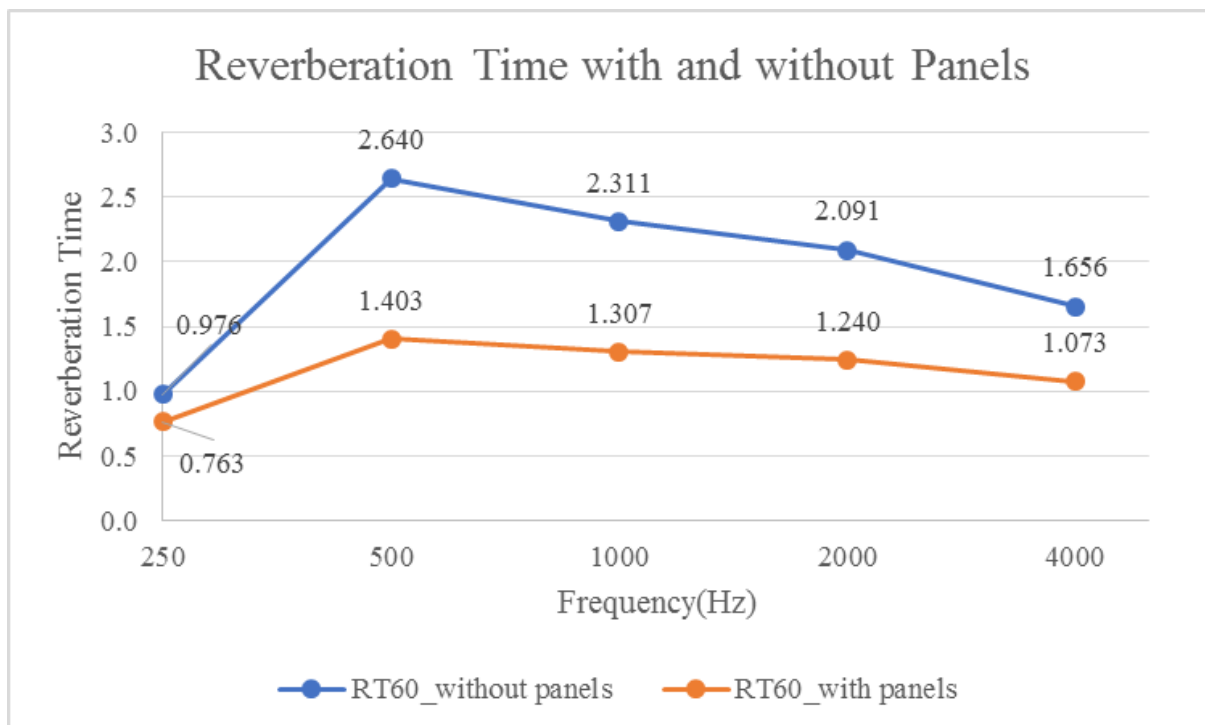
Since the presence of an audience plays a big role in auditorium acoustics, the calculations of how many panels needed assumes that the auditorium will host 400 people. Note another consideration is the audience in this auditorium will mostly comprise children with smaller body surface areas than those of the adults, thus the calculation is not based on a full-seated auditorium with 529 adults. Based on the

assumption of a total audience of 400 and the specified Knauf Black Acoustical Board absorption (2-inch-thick and 3.0 PCF density), the acoustics panel area needed for the auditorium is 33 m² (358 sq. feet).

The figure below shows the recommended reverberation time for 500Hz sound in rooms with various volumes. The current *RT60* is 2.64 s, which is too high for an auditorium with a volume of 100,000 ft³. The desired reverberation time for this auditorium is 1.4 s for the 500Hz octave band.



The following graph shows the measured reverberation time and the estimated reverberation time after the panel treatment at different frequency bands:



Sample Quotes:

Total material cost for the project: **\$2226** (not including shipping and installation)

- Knauf Ecosse Black Acoustical board – \$1112 total

45 panels in total with 8 ft² each.

(2 inch thick, 2' x 4', #3 density)

From Reverb.com, \$139 per 6 packs.

<https://reverb.com/item/355443-2-knauf-ecose-black-acoustical-board-2-inch-6-pack>

- Guilford of Maine acoustical fabric

\$975 in total plus shipping from Onlinefabricstore.net

<https://www.onlinefabricstore.net/guilford-of-maine-fr701-silver-papier-panel-fabric-.htm?gclid=CI6K9sD97NECFcaLswodTegK7g>

(16.25 per yard, 5.5ft width, 60 yard in total.

5.5'x3'per yard x60 yard=990 square ft)

