ACOUSTICAL INVESTIGATIONS OF MULTIPURPOSE SPACES AT COMMUNITY FACILITIES

Mandy Chan*[1], Michael Kundakcioglu †[1] and Alex P. Lorimer ‡[1]
[1]HGC Engineering, Mississauga, Ontario, Canada.

1 Introduction

Multipurpose spaces at community and recreational facilities hold significant value to the community, catering to a variety of uses and accommodating a diverse age range of users. The uses may include early childhood programs, sports activities, fitness classes, art and music lessons to community meetings, private events, etc.

Acoustical investigations were conducted at nine municipally owned facilities including community centres, arenas and a senior centre. Twenty multipurpose spaces were identified by the municipality with interior acoustic issues. Further information on the specific issues was not available.

This article describes the spaces investigated and outlines the applicable criteria, acoustic measurements and analysis. The contributing factors leading to the noise concerns for the spaces and considerations of acoustical treatment for interior acoustical control and background HVAC sound levels are also discussed. Extensive consideration was also given to sound isolation and, while not described herein, this could be the subject of a future article.

2 Description of the Spaces

Most of the facilities investigated were constructed within the past 25 years or renovated in the past 10 years. All the spaces were observed to be in good physical condition and the fixed wall assemblies were built with standard construction techniques with no obvious deficiencies.

For the acoustical investigation, the various multipurpose spaces were categorized into two different types of spaces: Community Rooms and Multipurpose Rooms.

Community Rooms were generally smaller sized rooms where classroom type learning environments may exist or meetings may take place (Figure 1).

Figure 1: Photo of a typical Community Room.

Multipurpose rooms are spaces that are larger in size with higher ceiling height, typical of a gymnasium or auditorium, and can be used for active recreation. The Multipurpose Rooms can typically be rented for private events which could involve live bands. Many of the Multipurpose Rooms included in this investigation were also equipped with room dividers to permit separate uses simultaneously within the large space (Figure 2).

Figure 2: Photo of a typical Multipurpose Room with divider.

Most of the spaces consist of suspended acoustical ceiling tiles and laminated hard surface flooring. In general, partitions separating the rooms did extend from slab to slab through the ceiling tiles, demising them from adjacent spaces. The wall partitions typically consisted of Gypsum Wall Board on studs, or painted concrete blocks.

3 Criteria

3.1 Reverberation

Reverberation is measured by the time it takes sound to die away in the space by 60 dB, using a quantity known as the reverberation time (RT_{60}). Excessive levels of reverberation cause the space to sound noisy or 'boomy' for some activities, limiting speech intelligibility and sound system functionality. In contrast, a lack of early reflections with the excessive use of absorptive treatments result in low levels of reverberation (a 'dead' space).

Based on a common reference [1], plus past experience, Table 1 summarizes our recommendations for the maximum mid-range target RT_{60} to be achieved in the multiuse spaces.

3.2 Background HVAC Sound Levels

The most universally accepted criteria for background sound levels are based on Noise Criterion (NC) curves developed by the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) [2]. Based on the ASHRAE Guidelines, the target maximum background sound levels are established.

* machan@hgcengineering.com
† mkundakcioglu@hgcengineering.com
‡ alorimer@hgcengineering.com

Table 1: Target Reverberation Criteria

Space	Target RT_{60} (Seconds)
Community Room	0.8
Multipurpose Room	1.2

In multipurpose spaces, where some level of background sound is helpful in reducing audibility and increasing the levels of perceived privacy, a background sound level in the range of NC-40 is appropriate where face to face communication is a consideration.

4 Results and Discussion

Physical inspections of the spaces were conducted and measurements were undertaken to determine the degree of reverberation, and to record the levels of background HVAC noise within the spaces.

4.1 Reverberation

The measured RT in the Community Rooms and Multipurpose Rooms are summarized in Figures 3 and 4 (target RT shown as black dashed line).

For the Community Rooms, most of the spaces were found to be within or near the target RT. These results indicate that for smaller sized rooms, an acoustical tiled ceiling can provide adequate reverberation control.

For the Multipurpose Rooms, the reverberation times were found to be high, with three spaces well exceeding the target. Due to the large volume of these spaces, an acoustic tiled ceiling does not provide sufficient reverberation control and additional acoustic treatment is required. For the Multipurpose Room where the measured RT exceeded 4 seconds, it was determined that the acoustic ceiling tiles were painted over thus rendering the ceiling non-absorptive and ineffective.

Further treatment would be beneficial for the acoustical environment of the spaces where the RT was found to be slightly above the target. A small amount of acoustically absorptive panels distributed evenly across the walls was calculated to be sufficient treatment. For rooms where the measured RT was significantly higher than the target, the most effective option was to replace the acoustic ceiling tiles with higher absorption tiles and include acoustically absorptive panels distributed evenly across the walls, approximlately 10 to 30% of wall coverage.

4.2 Background HVAC Sound Levels

The measured background sound levels in most of the rooms were found to be quite high, ranging from NC-40 to NC-50, indicating that background sound levels are a major factor contributing to a perception of poor acoustics in the rooms.

In many instances, it was found that the HVAC system serving the space consisted of rooftop units positioned directly above the supply air diffusers serving the space, suggesting that there is very little room for mitigation measures of duct borne noise. With the insufficient room for attenuation in the ductwork, a silencer or upgraded roof curb for the air handling unit would likely be the most effective approach. Acoustic duct liner within the ductwork could help decrease the sound levels further, but the ductwork may need to be resized to accommodate the thickness of the liner, and longer ductwork lengths, preferably on the roof, may be necessary for this method to provide any notable benefit.

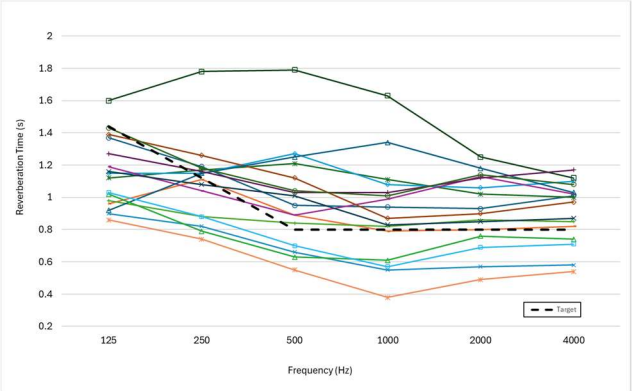

Figure 3: Measured Reverberation Times in Community Rooms

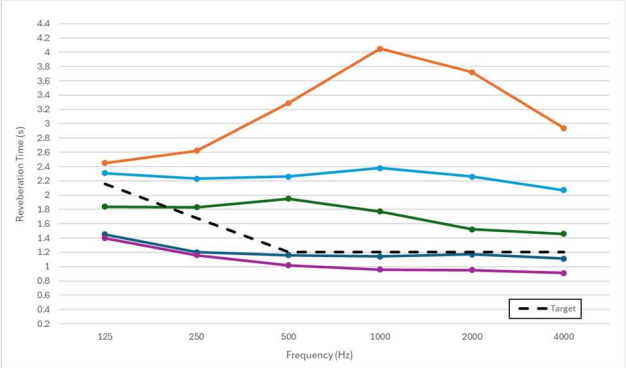

Figure 4: Measured Reverberation Times in Multipurpose Rooms

5 Conclusion

Based on a relatively large sampling of similar-use spaces, the results of this investigation indicated that an acoustic absorptive ceiling can provide adequate reverberation control for most standard-height multipurpose spaces. For larger multipurpose spaces, acoustically absorptive wall panels in addition to an acoustically absorptive ceiling would be required. High background sound levels due to HVAC noise were found to be a major factor contributing to a perception of poor acoustics in the multiuse spaces. The placement of rooftop units and duct paths should be taken into consideration when designing the HVAC systems for multipurpose spaces to avoid negatively impacting the acoustic environment.

References

[1] Egan, M.D. "Architectural Acoustics" J. Ross Publishing, Originally Published by McGraw Hill Book Co., 1988

[2] American Society for Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE), "HVAC Systems Applications Handbook", Atlanta, GA, 2007.