

DESIGN OF A CLASSROOM FOR DEAF / HEARING IMPAIRED STUDENT EDUCATORS

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1. INTRODUCTION

Toronto's York University offers the only full-time Deaf Education Program in Ontario and the biggest one of four in Canada. Formerly known as the Teacher Preparation Program in the Education of Deaf and Hard of Hearing Students, this 10-month program teaches future teachers of the deaf and hard of hearing. The program graduates about 20 students per year.

To facilitate instruction of student teachers, many of whom are themselves deaf or hard of hearing, an existing seminar room was retrofitted as a special deaf education classroom in 1993. The classroom was equipped for multi-media presentation with assistive listening devices and designed with room acoustics consistent for high speech intelligibility, particularly in the context of the hearing impaired. Considerations incorporated as objectives into the design included: maximum 500 Hz RT60 values of 0.4 seconds; signal to noise ratios of 20 dB with normal vocal effort; reinforcing reflections within 20 milliseconds; and maximum background noise levels of NC-15 to NC-20.

Assessment of acoustical performance by measurements conducted in 1997 about three years after the facility opened, indicated the facility conformed to most design objectives¹. Subjective feedback from users indicated a high degree of satisfaction, especially from the hard of hearing students. However, normal hearing students indicated concerns with the space and "have commented that they feel a bit cut off from the outside environment due to the quietness in the room." With 10 years of use, user satisfaction with the space was again recently evaluated. User feedback is discussed herein.

2. ROOM CHARACTERISTICS

Figure 1, illustrates the space layout and finishes. Table 1 summarizes measured acoustical parameters compared with the design criteria.

3. USER FEEDBACK

Hard of hearing students are very satisfied with the space as assistive listening devices and microphones work well in the low noise and low reverberation space.

Consistent with the earlier assessment, normal hearing students still feel isolated and the space is oppressively quiet. Faculty have surmised that the sense of isolation felt by some students is the same phenomenon encountered in clinical audiology where patients dislike the audiometric booths due to the low reverberation and high sound isolation, characteristics atypical of spaces found in most buildings.

A new concern expressed by the normal hearing students and staff is insufficient signal (likely lack of strong early reflections). Staff have indicated the need to "raise my voice when I teach and that I am tired by the end of a lecture because of that; if I do not raise my voice, the normal hearing students do not hear well enough (similarly, the students need to raise their voices when they are making a comment to the class as otherwise, only the hard of hearing students can hear them with the hand held mics)".

Two other new concerns raised by users - dust buildup on acoustic finishes and poor air quality (stuffy room), indirectly relate to acoustical considerations. Dust buildup is a by-product of normally porous acoustical finishes. Poor air quality potentially is related to low velocity ventilation systems (to reduce noise) and constrained by the original ductwork sized for higher air speeds. As a result of the stale air, the doors are often left open, degrading the sound isolation.

4. DISCUSSION / CONCLUSIONS

The subjective feedback of users is consistent with a bias in the design towards hearing impaired listeners. Given the mix of students (about 12% "hard of hearing", 25% deaf and the balance normal hearing) the design may have been too heavily weighted towards

Table 1: Summary of Design Criteria and Measured Performance

Parameter	Proposed Design Criteria: Classroom for the Hearing Impaired	Typical Criteria: Classroom for Normal Hearing	Measured Value: York University Deaf Education Classroom
Ambient Noise Level	PNC / NC 20 or less (30 dBA or less)	PNC / NC 30 - 35 (40-44 dBA)	NC 30 - 35 (41 dBA)
Reverberation Time (RT60)	0.4 seconds maximum @ 500 Hz	0.6 - 0.8 seconds @ 500 Hz	0.4 seconds @ 500 Hz
Minimum Signal to Noise Ratio (S/N), Normal Vocal Effort	20 dB	15 dB	16 dB- 21 dB
Arrival of Reinforcing Reflections	Within 20 msec of direct sound, Clarity ratio $C_{\text{arrival time } +20\text{ms}}$ of 10 dB or more	Within 35 msec of direct sound, Clarity ratio $C_{\text{arrival time } +35\text{ms}}$ of 10 dB or more	Clarity ratio $C_{\text{arrival time } +20\text{ms}}$ of 8 - 10 dB
Articulation Loss (% ALCons)	% ALCons < 3%	%ALCons <10%	%ALCons : 2.5 % -3.4%
Speech Transmission Index (STI)	STI > 0.75	STI > 0.55	STI: 0.73 - 0.78
Sound Isolation (STC or NIC)	STC or NIC: 55- 60 to traffic areas or adjacent classrooms	STC 50 (walls) to traffic areas, STC 25-30 (doors)	STC 30 to corridor NIC 34 to corridor (doors)

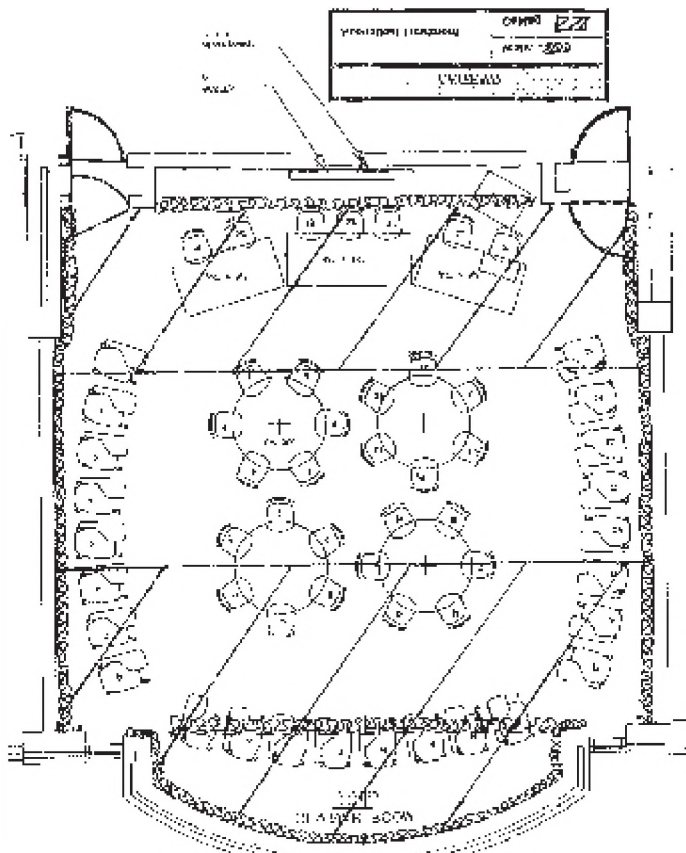


Figure 1: Space Layout and Finishes (adapted from ref. 2)

room acoustics for assistive listening. The major factor contributing to the perceived low signal levels are due to reduced strong early reflections (although, the measured clarity ratios are marginally within specification). While the plan view indicated in Figure 1 suggests central portions of the ceiling remain sound reflective, for architectural consistency these were made sound absorptive. User impressions are that the room functions extremely well with supplementary sound reinforcement.

Issues associated with ventilation and dust as related to acoustics / noise control, highlights the importance of a holistic design approach and coordination among all of the designers and users.

5. REFERENCES

1. Chin-Quee, D.A. "Acoustical Design Parameters for Hearing Impaired Classrooms: A Case Study", *Proceedings of Noise-Con 97*, pp 423 -426 June 1997.
2. D.A.Chin-Quee, "York University Hearing Impaired Classroom Remedial Acoustical Treatment", *Valcoustics Canada Ltd. Report 92-093*, 1993.

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