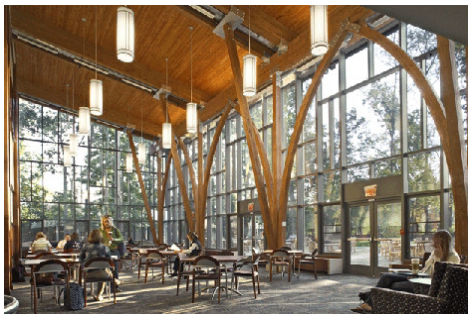
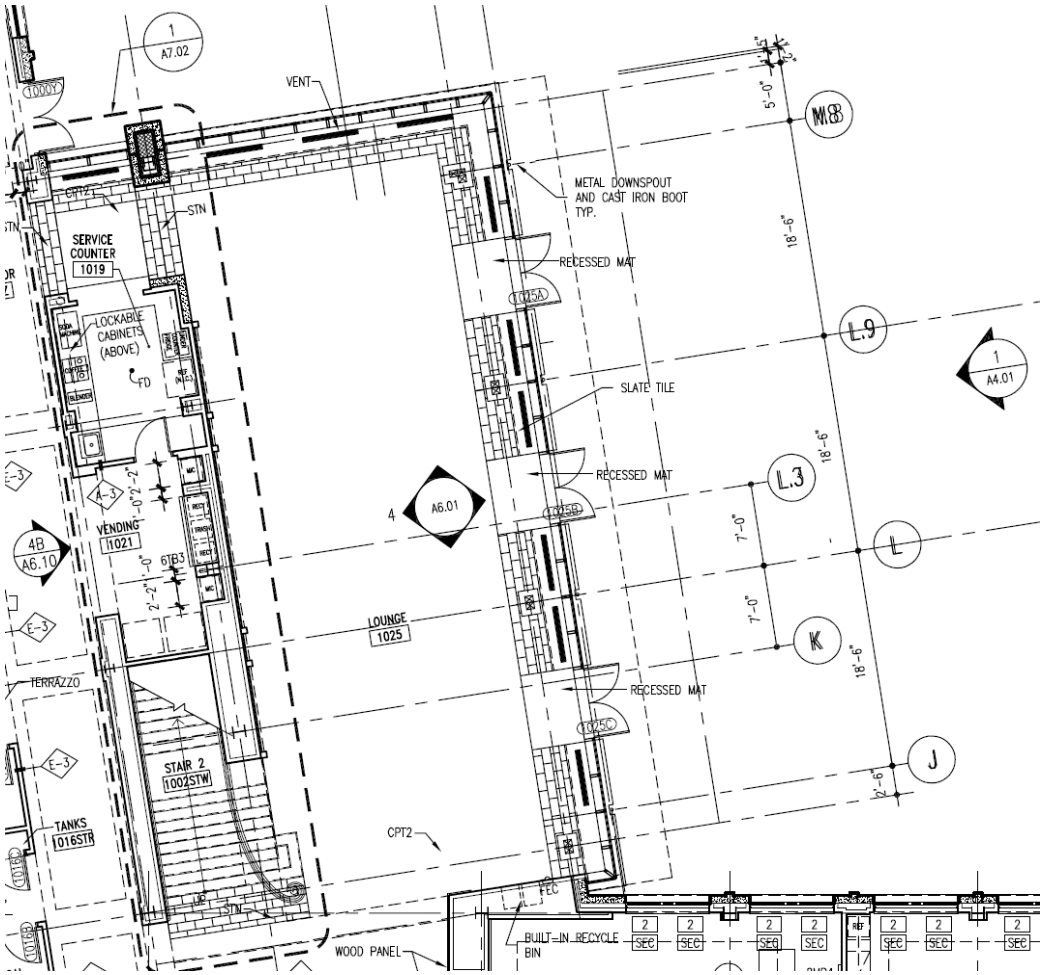
Acoustical Breadth



Introduction

The Café DUSON Student Lounge is a large double high space that contains a large amount of wood, glass, and painted gypsum wall board. These materials are highly reflective acoustically. The space also contains two large parallel walls, one of which is the large glass curtain wall in front of the arches. The parallel walls can create flutter echoes if not treated correctly. Since this space is designed to be a relaxing study lounge and a general gathering space, reverberation times are critical to limit the amount of noise in the space. For this reason a reverberation time (T_{60}) study will be conducted to determine what measures need to be addressed to correct these times.

Architectural Plan



Reverberation Time Calculations

Existing Reverberation Time (T_{60}) Calculation							
Surface Description	[S] Surface Area (ft^2)	Absorption Coefficient (α)					
		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Thin Carpet Flooring on Concrete	1843.0	**0.020**	**0.060**	**0.140**	**0.570**	**0.600**	**0.650**
A = S(α)		36.86	110.58	258.02	1050.51	1105.80	1197.95
Wood Tongue and Groove Ceiling	1710.0	**0.240**	**0.190**	**0.140**	**0.080**	**0.130**	**0.100**
A = S(α)		410.40	324.90	239.40	136.80	222.30	171.00
Wood Ceiling Beams	985.5	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		147.83	108.41	98.55	68.99	59.13	68.99
Wood Support Beams	243.3	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		36.49	26.76	24.33	17.03	14.60	17.03
Wood Columns	188.4	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		28.27	20.73	18.84	13.19	11.31	13.19
Wood Suport Arches	244.4	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		36.67	26.89	24.44	17.11	14.67	17.11
Wood Arches	340.0	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		51.00	37.40	34.00	23.80	20.40	23.80
Concrete Footings	50.3	**0.010**	**0.010**	**0.015**	**0.020**	**0.020**	**0.020**
A = S(α)		0.50	0.50	0.75	1.01	1.01	1.01
Wood Railing	13.1	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		1.97	1.44	1.31	0.92	0.79	0.92
Exterior Glass, 1"	2126.8	**0.180**	**0.060**	**0.040**	**0.050**	**0.020**	**0.020**
A = S(α)		382.83	127.61	85.07	106.34	42.54	42.54
Thin Fabric Wall Panels	380.3	**0.030**	**0.040**	**0.110**	**0.170**	**0.240**	**0.350**
A = S(α)		11.41	15.21	41.83	64.65	91.27	133.11
Wood Paneling, 1/4", with airspace behind	211.7	**0.420**	**0.210**	**0.100**	**0.080**	**0.060**	**0.060**
A = S(α)		88.91	44.46	21.17	16.94	12.70	12.70
Inner Wall Wood Beam Columns	225.1	**0.150**	**0.110**	**0.100**	**0.070**	**0.060**	**0.070**
A = S(α)		33.77	24.77	22.51	15.76	13.51	15.76
GWB, 1/2", on 2x4 studs	1539.7	**0.290**	**0.100**	**0.050**	**0.040**	**0.070**	**0.090**
A = S(α)		446.51	153.97	76.99	61.59	107.78	138.57

Recommended Reverberation Times

Room volume = 1270 m^3

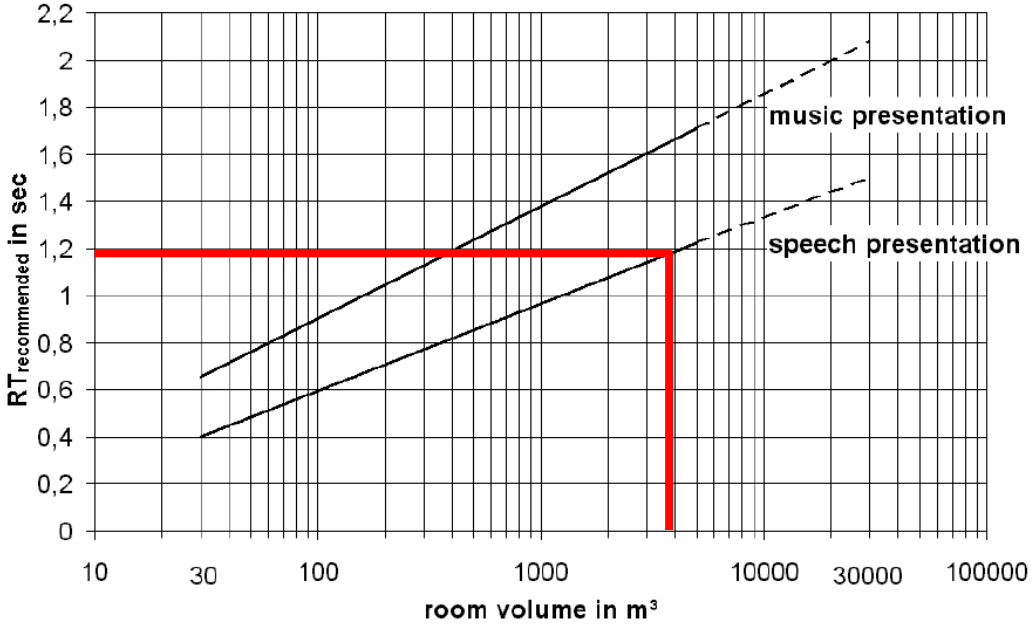


Figure 1.1: Recommended value of the mean reverberation time $RT_{recommended}$ from 500 Hz to 1000 Hz for speech and music presentations as a function of room volume V

Existing Reverberation Times

Existing Reverberation Time (T_{60}) Calculation							
		Frequency					
Room Volume (67.5' X 27.25' X 24') ft^3=	44145	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Reverberation Time (Seconds)	T_{60}= 0.049V/ΣA	1.26	2.11	2.28	1.36	1.26	1.17
Target Reverberation Time (Figure 1.1 Value)	1-2 sec	Acceptable	Not Acceptable	Not Acceptable	Acceptable	Acceptable	Acceptable

After performing the existing reverberation time calculations the times for the 250Hz and the 500Hz frequencies fell above the recommended reverberation time of 1- 2 seconds. These frequencies make up part of the sound energies in speech that contain vowels. Since the vowels make up 75% of sound energy in speech, it is this part of the spectrum that accounts for quality of a person's speech.

In order to correct these reverberation times, more absorptive material is required in the space. Since two of the café's walls are glass and the ceiling is exposed architectural wood, the properties of one or both of the remaining two walls must become slightly more absorptive. Some of the materials on the large non-glass wall, the wall opposite the arches, are thin fabric wrapped panels. The following table shows the calculations for changing those thin fabric wrapped panels to heavier fabric wrapped on 5/8" perforated mineral board panels.

Corrected Reverberation Time (T_{60}) Calculation							
Surface Description	[S] Surface Area (ft^2)	Absorption Coefficient (α)					
		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Thin Carpet Flooring on Concrete	1843.0	0.020	0.060	0.140	0.570	0.600	0.650
A = S(α)		36.86	110.58	258.02	1050.51	1105.80	1197.95
Wood Tongue and Groove Ceiling	1710.0	0.240	0.190	0.140	0.080	0.130	0.100
A = S(α)		410.40	324.90	239.40	136.80	222.30	171.00
Wood Ceiling Beams	985.5	0.150	0.110	0.100	0.070	0.060	0.070
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A = S(α)		51.00	37.40	34.00	23.80	20.40	23.80
Concrete Footings	50.3	0.010	0.010	0.015	0.020	0.020	0.020
A = S(α)		0.50	0.50	0.75	1.01	1.01	1.01
Wood Railing	13.1	0.150	0.110	0.100	0.070	0.060	0.070
A = S(α)		1.97	1.44	1.31	0.92	0.79	0.92
Exterior Glass, 1"	2126.8	0.180	0.060	0.040	0.050	0.020	0.020
A = S(α)		382.83	127.61	85.07	106.34	42.54	42.54
Carpet, heavy, on 5/8-in perforated mineral board	380.3	0.37	0.410	0.630	0.850	0.960	0.920
A = S(α)		140.71	155.92	239.59	323.26	365.09	349.88
Wood Paneling, 1/4", with airspace behind	211.7	0.420	0.210	0.100	0.080	0.060	0.060
A = S(α)		88.91	44.46	21.17	16.94	12.70	12.70
Inner Wall Wood Beam Columns	225.1	0.150	0.110	0.100	0.070	0.060	0.070
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Corrected Reverberation Time (T_{60}) Calculation							
		Frequency					
Room Volume (67.5' X 27.25' X 24') =	44145	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Reverberation Time (Seconds)	T_{60}= 0.049V/ΣA	1.17	1.86	1.89	1.17	1.09	1.04
Target Reverberation Time (Figure 1.1 Value)	1-2 sec	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

Cost Analysis

Acoustical Cost Estimate			
Material Description	**Surface Area (SF)**	**Cost/SF**	**Total Cost**
Existing Thin Fabric Wrapped Panels	380.3	$6.97	$2,650.69
Proposed Carpet, heavy, on 5/8-in perforated mineral board	380.3	$8.97	$3,411.29
		Total Acoustical Cost Difference	($760.60)

*All unit cost values obtained from 2008 RS Means

Conclusion

The sound quality of the space was improved by reaching the recommended reverberation time range with the modification to the fabric wrapped panels on the west wall. The cost analysis determined that by spending an extra $770 on material cost for the space the reverberation times fall with the recommended range for the space. In conclusion it is recommended that this relatively minimal cost is worthwhile in improving the sound quality of the room.