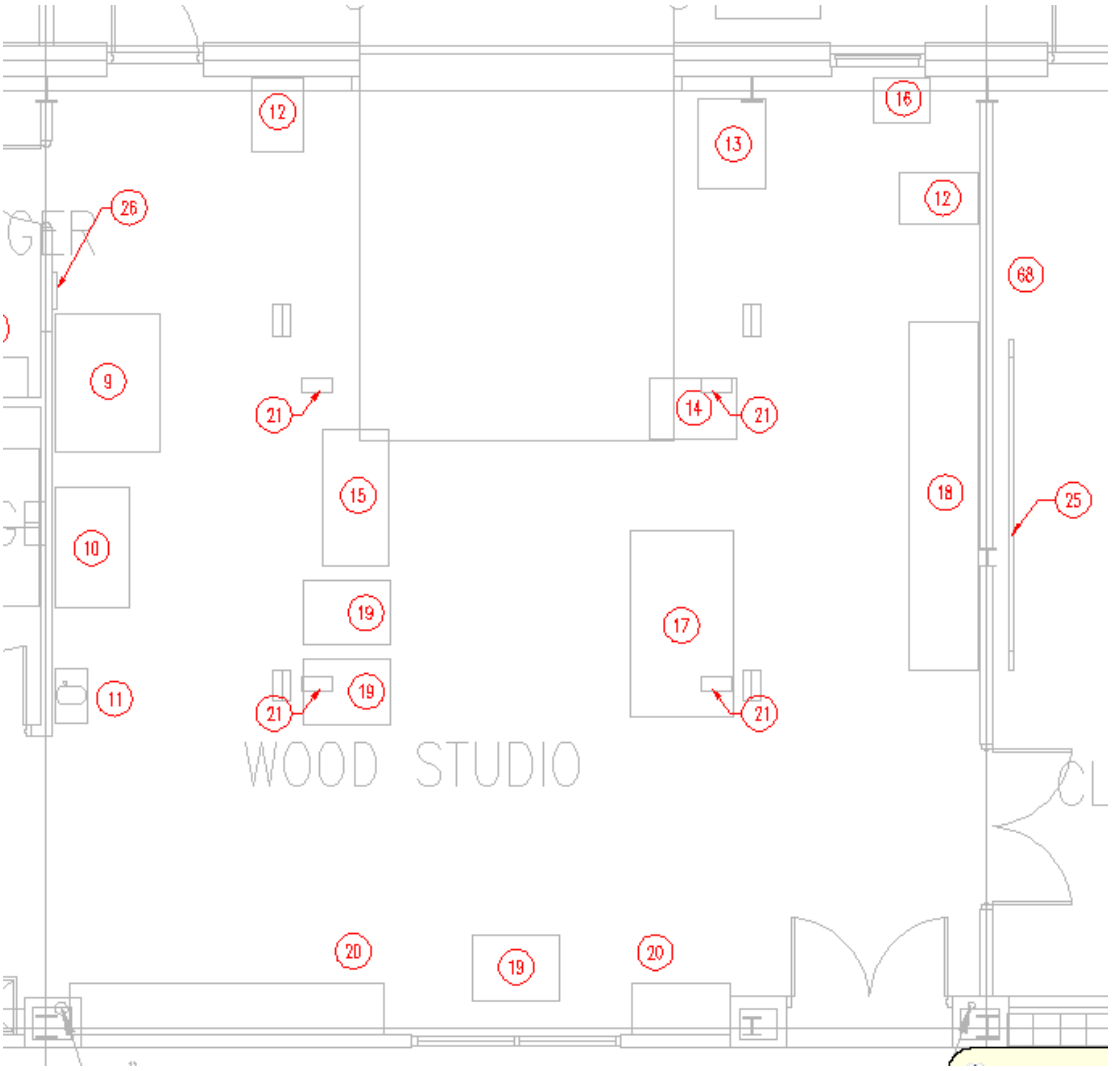
Acoustical Breadth

The acoustical breadth scope was to analyze the existing conditions in the wood shop classroom and surrounding areas on the lower level of the building. The criteria used to evaluate the existing system are noise level in the room, reverberation time and sound transmission loss.

Not all acoustical properties could be found for each material in the space, therefore the most appropriate approximation was made in each instance. Additionally, the noise levels of the room were estimated by taking a sound meter to the SALA building wood shop and measure existing conditions.

Equipment Floor Plan



Equipment Schedule

Equipment Schedule	
Tag	**Description**
9	Radial Arm Saw
10	Chop Saw
11	Drill Press
12	Band Saw 14"
13	Band Saw large
14	Planer
15	Table Saw 63"x30"
17	large work table
18	panel saw
19	Small Work Table
20	Storage Shelving
21	Cord Reel receptacle
26	Wall Clock

Existing Noise Conditions

Wood Studio Existing Noise Conditions (Noise Level dB)						
Condition	**125Hz**	**250Hz**	**500 Hz**	**1000Hz**	**2000Hz**	**4000Hz**
Max Conidition	101	100	102	100	104	105
Dust Collector Only	72	73	75	71	70	69

Reverberation Time Analysis

Wood Studio Existing Acoustical Analysis			125 Hz		250 Hz		500 Hz		1000 Hz		2000 Hz		4000 Hz	
Surface Description	**Material**	**Surface Area (S)**	**α**	**a**	**α**	**a**	**α**	**a**	**α**	**a**	**α**	**a**	**α**	**a**
Floor	Sealed Concrete	1409.0	0.01	14.09	0.01	14.09	0.01	14.09	0.02	28.18	0.02	28.18	0.02	28.18
Ceiling	Acoutical Ceiling Tile	1409.0	0.27	380.43	0.60	845.40	0.64	901.76	0.80	1127.20	0.91	1282.19	0.99	1394.91
North Wall	Wall Type 2D	448.0	0.16	71.68	0.07	31.36	0.04	17.92	0.04	17.92	0.03	13.44	0.03	13.44
Main Entrance Door Wall	Wall type 4B	140.0	0.27	37.80	0.10	14.00	0.05	7.00	0.04	5.60	0.03	4.20	0.03	4.20
East Wall Glazing	Glazing Type G4A	51.4	0.15	7.70	0.05	2.57	0.04	2.05	0.03	1.54	0.02	1.03	0.02	1.03
East Wall	Wall Type 4B	84.0	0.27	22.68	0.10	8.40	0.05	4.20	0.04	3.36	0.03	2.52	0.03	2.52
East Wall	Wall Type 2D	291.6	0.16	46.66	0.07	20.42	0.04	11.67	0.04	11.67	0.03	8.75	0.03	8.75
East Wall	Wall Type 2D	133.0	0.16	21.28	0.07	9.31	0.04	5.32	0.04	5.32	0.03	3.99	0.03	3.99
South Wall	Wall Type 2D	119.0	0.16	19.04	0.07	8.33	0.04	4.76	0.04	4.76	0.03	3.57	0.03	3.57
East Tool Cage Wall	Wall Type 1A	126.0	0.14	17.64	0.06	7.56	0.04	5.04	0.03	3.78	0.03	3.78	0.03	3.78
North Tool Cage Wall	Wall Type 1A	300.3	0.14	42.05	0.06	18.02	0.04	12.01	0.03	9.01	0.03	9.01	0.03	9.01
Tool Cage wall Glazing	Glazing Type G8	28.7	0.15	4.30	0.05	1.43	0.04	1.15	0.03	0.86	0.02	0.57	0.02	0.57
West Wall	Wall Type 2C	333.0	0.22	73.26	0.08	26.64	0.05	16.65	0.04	13.32	0.03	9.99	0.03	9.99
West Wall Overhead Door	Aluminum	150.0	0.01	1.50	0.01	1.50	0.01	1.50	0.02	3.00	0.02	3.00	0.02	3.00
West Wall Glazing	Glazing G	25.1	0.15	3.76	0.05	1.25	0.04	1.00	0.03	0.75	0.02	0.50	0.02	0.50
Wood Door	Wood	168.0	0.10	16.80	0.11	18.48	0.10	16.80	0.08	13.44	0.08	13.44	0.11	18.48
Steel Door	Steel	21.0	0.01	0.21	0.01	0.21	0.01	0.21	0.02	0.42	0.02	0.42	0.02	0.42
Room Volume ft^3		19726												
Σa			780.9		1029.0		1023.1		1250.1		1388.6		1506.3	
Reverberation Time T= (.05V/ΣA)			1.3		1.0		1.0		0.8		0.7		0.7	
Target Time			0.7-1.1sec		0.7-1.1sec		0.7-1.1sec		0.7-1.1sec		0.7-1.1sec		0.7-1.1sec	

Based on the existing materials in the room, the reverberation time for the room meets the target time of 0.7sec-1.1 sec for demonstration and teaching purposes for all but the 125 Hz frequency which is 0.2 seconds over. Based on this data I found it unnecessary to modify the materials in the room.

Noise Reduction

A noise reduction analysis performed below will analyze if the noise from the wood shop will transmit into the crit room which is across the common corridor.

Composite TL Calculation for Shared Wall

TL Calculation													
Surface Description	Surface Area	TL @ 125 Hz	τ @ 125Hz	TL @ 250 Hz	τ @ 250 Hz	TL @ 500 Hz	τ @ 500 Hz	TL @ 1000 Hz	τ @ 1000 Hz	TL @ 2000 Hz	τ @ 2000 Hz	TL @ 4000 Hz	τ @ 4000 Hz
Wall	348.5	29	0.0013	41	8E-05	51	8E-06	56	3E-06	43	5E-05	48	1.6E-05
door	21	14	0.0398	15	0.0316	17	0.02	18	0.0158	22	0.00631	29	0.00126
glass	49	30	0.001	33	0.0005	36	0.0003	32	0.0006	40	0.0001	50	0.00001
ΣS	418.5												
Composite TL		25.00		27.67		29.84		30.60		34.32		41.10	

Wood Shop to Corridor Transmission

Noise Reduction (Wood Shop -> Corridor)							
Surface Description	Surface Area (ft^2)	(α) 125Hz	(α) 250Hz	(α) 500Hz	(α) 1000Hz	(α) 2000Hz	(α) 4000Hz
Floor	372	0.01	0.01	0.01	0.02	0.02	0.02
Common Wall	348.5	0.16	0.07	0.04	0.04	0.03	0.03
Common Wall Door	21	0.10	0.11	0.10	0.08	0.08	0.11
Common Wall Glazing	49	0.15	0.05	0.04	0.03	0.02	0.02
Crit Room Wall	418.5	0.22	0.08	0.05	0.04	0.03	0.03
Ceiling	372	0.27	0.60	0.64	0.80	0.91	0.99
A_2= ΣSα		261.44	289.56	280.725	338.87	371.63	402.02
Composite TL Common Wall		24.99886	27.666	29.8412	30.5986	34.3174	41.1047
10 log a2/S		-2.043234	-1.5996	-1.7341	-0.9166	-0.51585	-0.17448
NR= TL + 10 log a2/S		22.95563	26.066	28.1071	29.6819	33.8015	40.93022

Noise Levels in Corridor

Corridor Existing Noise Conditions (Noise Level dB)						
Condition	**125Hz**	**250Hz**	**500 Hz**	**1000Hz**	**2000Hz**	**4000Hz**
Max Conidition	78.04	73.93	73.89	70.32	70.20	64.07
Dust Collector Only	49.04	46.93	46.89	41.32	36.20	28.07

Corridor to Crit Room Transmission

Noise Reduction (Corridor -> Crit Room)							
Surface Description	**Surface Area (ft^2)**	**(α) 125Hz**	**(α) 250Hz**	**(α) 500Hz**	**(α) 1000Hz**	**(α) 2000Hz**	**(α) 4000Hz**
Floor (Concrete)	382	0.01	0.01	0.01	0.02	0.02	0.02
Common Wall	348.5	0.16	0.07	0.04	0.04	0.03	0.03
Walls	1016.4	0.10	0.11	0.10	0.08	0.08	0.11
Ceiling (Exposed)	382	0.10	0.05	0.06	0.07	0.09	0.08
$A_2 = \Sigma S\alpha$		199.42	159.12	142.32	129.63	133.79	160.46
Common Wall		24.00	37.00	44.00	49.00	36.00	41.00
10 log a2/S		-2.42	-3.40	-3.89	-4.29	-4.16	-3.37
NR= TL + 10 log a2/S		21.58	33.60	40.11	44.71	31.84	37.63

Noise levels in Crit Room

Crit Room Existing Noise Conditions (Noise Level dB)						
Condition	**125Hz**	**250Hz**	**500 Hz**	**1000Hz**	**2000Hz**	**4000Hz**
Max Conidition	56.47	40.34	33.78	25.61	38.36	26.44
Dust Collector Only	27.47	13.34	6.78	0.00	4.36	0.00

Recommended NC Curve

Crit Recommended Noise Criteron Curve						
NC 25	**125Hz**	**250Hz**	**500 Hz**	**1000Hz**	**2000Hz**	**4000Hz**
db	45	38	31	27	25	21

Redesigned Crit Room/Corridor wall construction

Existing 3 5/8" 20 gauge metal studs with GWB on each side

Redesigned Construction 3 5/8" 24 gauge metal studs with 2 layers of 5/8" GWB and 3" fiberglass insulation

Redesigned Corridor to Crit Room Transmission

Noise Reduction (Corridor -> Crit Room)							
Surface Description	**Surface Area (ft^2)**	**(α) 125Hz**	**(α) 250Hz**	**(α) 500Hz**	**(α) 1000Hz**	**(α) 2000Hz**	**(α) 4000Hz**
Floor (Concrete)	382	0.01	0.01	0.01	0.02	0.02	0.02
Common Wall	348.5	0.16	0.07	0.04	0.04	0.03	0.03
Walls	1016.4	0.10	0.11	0.10	0.08	0.08	0.11
Ceiling (Exposed)	382	0.10	0.05	0.06	0.07	0.09	0.08
$A_2 = \Sigma S\alpha$		199.42	159.12	142.32	129.63	133.79	160.46
Composite TL Common Wall		38.00	52.00	59.00	60.00	56.00	62.00
10 log a2/S		-2.42	-3.40	-3.89	-4.29	-4.16	-3.37
NR= TL + 10 log a2/S		35.58	48.60	55.11	55.71	51.84	58.63

Noise Levels in redesigned Crit Room

Crit Redesigned Noise Conditions (Noise Level dB)						
Condition	**125Hz**	**250Hz**	**500 Hz**	**1000Hz**	**2000Hz**	**4000Hz**
Max Conidition	42.47	25.34	18.78	14.61	18.36	5.44
Dust Collector Only	13.47	0.00	0.00	0.00	0.00	0.00

Recommended NC Curve

Crit Recommended Noise Criteron Curve						
NC 25	**125Hz**	**250Hz**	**500 Hz**	**1000Hz**	**2000Hz**	**4000Hz**
db	45	38	31	27	25	21

Evaluation

Initial analysis of the wood shop helped lead my design as I originally intended to try and quiet the wood shop room itself. After trying numerous attempts I found this to be a lost cause. I then turned my attention towards sound isolation. Occupants within the wood shop would be wearing ear protection from the harmful noises, therefore the main goal was to make sure the wood shop did not disturb adjacent spaces. While not exactly adjacent, the crit room, across the corridor from the woodshop, was used to evaluate sound propagation through the existing building construction. It was found that the proposed design would create unsatisfactory noise levels in the crit room while the machines were running in the wood shop. It was then determined that the most cost effective method to isolate the crit room from this noise was to redesign the wall construction. By changing to 3 5/8" 24 gauge metal studs with 2 layers of 5/8" GWB and 3" fiberglass insulation, noise transmission was able to be limited to meet the target noise criterion (NC) of 25.