Assignment Title: Live Venue Design

Module: VEPT20012
Acoustic and Electronics

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Contents

Introduction

The goals of this venue are to have a reverberation time at 0.8 seconds or lower, to use appropriate absorbers/diffusors to reduce the reverberation time and tackle any issue in the room and to select a speaker system that has an adequate SPL level and excellent coverage. Lastly to understand issues that occur with venues and how to correct/reduce them.

1. Main Body

1. Room Size & Shape

The dimensions of Metronome: 17.18m Length, 10.96m Width and 4.3m Height. Due to the size of Metronome, the capacity will be 300 people, and to simplify matters, the seating area will not be considered.

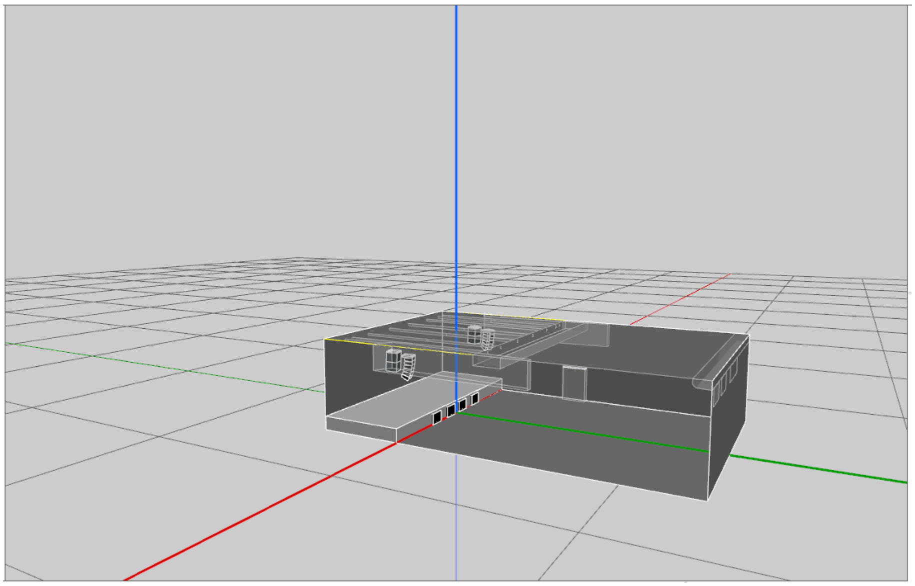


Figure 1 Metronome Shoebox Shape

Metronome is a shoebox, which is a straight-forward design (Figure 1). But is limited from its size, if Metronome was bigger the audience at the back would not hear the music as loud, covering the ends of the room with consistent volume is difficult. Metronome is not wide so covering the sound width-wise is easy. (Everest, 2014)

Compared to a room with splayed walls, wider walls mean the back audiences do not lose out, but flutter echoes can be created in the back of splayed rooms. (Figure 2) (Everest, 2014)

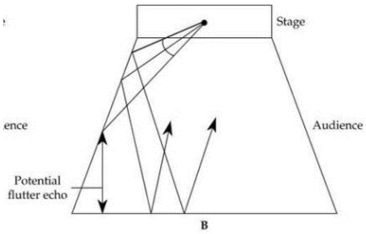


Figure 2 Splayed Walls/ Flutter Echo

Metronome has two flutter echoes, one near the back of the room and one at the doors. (Figure 3)

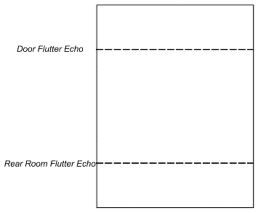
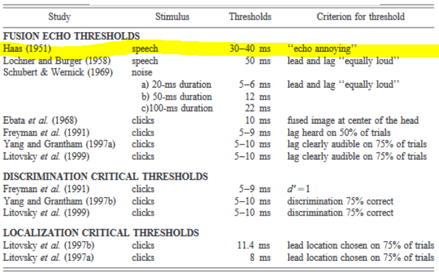


Figure 3 Metronome's Flutter Echoes

Because they are parallel with the opposite surface with no absorption placed. Why this happens is because the sound source reflects back and forth identically each reflection. It is outside the Haas Fusion Zone, if the reflection is longer than 40ms then the listener can hear the difference between the source and reflection. (Everest, 2014) (Litovsky, 1999) (Figure 4)



Study	Stimulus	Thresholds	Criterion for threshold
FUSION ECHO THRESHOLDS			
Haas (1951)	speech	30–40 ms	"echo annoying"
Lochner and Burger (1958)	speech	50 ms	lead and lag "equally loud"
Schubert & Wernick (1969)	noise		
	a) 20-ms duration	5–6 ms	lead and lag "equally loud"
	b) 50-ms duration	12 ms	
	c)100-ms duration	22 ms	
Ebata *et al.* (1968)	clicks	10 ms	fused image at center of the head
Freyman *et al.* (1991)	clicks	5–9 ms	lag heard on 50% of trials
Yang and Grantham (1997a)	clicks	5–10 ms	lag clearly audible on 75% of trials
Litovsky *et al.* (1999)	clicks	5–10 ms	lag clearly audible on 75% of trials
DISCRIMINATION CRITICAL THRESHOLDS			
Freyman *et al.* (1991)	clicks	5–9 ms	$d' = 1$
Yang and Grantham (1997b)	clicks	5–10 ms	discrimination 75% correct
Litovsky *et al.* (1999)	clicks	5–10 ms	discrimination 75% correct
LOCALIZATION CRITICAL THRESHOLDS			
Litovsky *et al.* (1997b)	clicks	11.4 ms	lead location chosen on 75% of trials
Litovsky *et al.* (1997a)	clicks	8 ms	lead location chosen on 75% of trials

Figure 4 Haas Fusion Zone 30-40ms

To avoid flutter echoes, place a diffuser/absorber at one of the surfaces. Angling the diffuser/absorber will make it easier. (Everest, 2014)

2. Room Frequency Response

Schroeder found that rooms have two energy types, Resonator, that consists of modes and uneven listening in smaller rooms. Reflectors are reflections travel around the room until their energy is depleted. (Sound&Vision, 2012)

Schroeder worked out the crossover point of the resonator and reflector is with the equation, $2,000*\sqrt{}\,(RT\text{-}60(\text{Lowest Hz})/Vol(\text{m})) = SF.$ (AcousticFields.com, 2016) The SF of Metronome is 42.5Hz. This will help for the selection of absorbers.

Knowing a Room's Frequency Response will help establish what needs to be done next. (Figure 5) Above 500Hz is dense, there are no considerable peaks and troughs, this means barely any EQ will be needed.

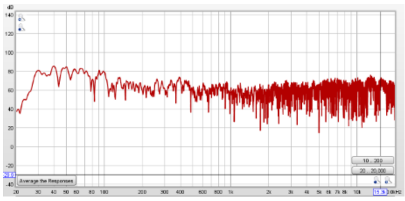


Figure 5 Metronome's Frequency Response

The data shows that below 500Hz, areas need equalization. A peak starts at 370Hz/412Hz, it lacks wideness but is louder than average peak by 6dB, thus problematic as these frequencies lie within the 125Hz/500Hz muddy bandwidth, since the level is higher, the reflections will last longer. This affects the sound quality and reverberation. (Stofringsdal, 2013) 350Hz/450Hz has the fullness of the snare, guitar and vocals. EQ will be applied to the speakers to balance this peak by 6dB. (Interactive Frequency Chart, 2006) This corrective speaker equalization will be done through-out the frequency bandwidth to balance peaks and troughs.

3. Reverberation Time

A factor of reverberation is the Reverb Tail, as when the sound source is turned off the room will still resonate with reflections. But the reflections will decay, as reflections lose energy every time they reflect, and travel through air. But with the amount of reflections, the decay is a smooth process. (Everest, 2014) (Figure 6)

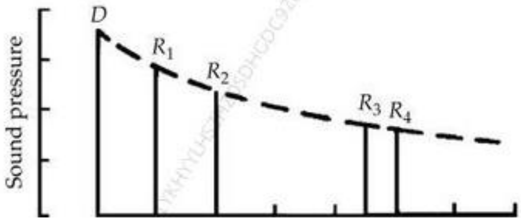
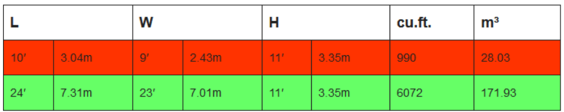


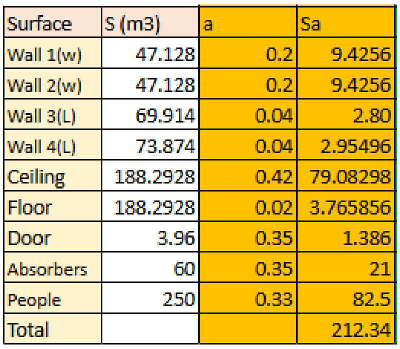
Figure 6 Reverb Tail

A way to measure the reverb tail is by using RT_{60}, which is calculation to find out how long it takes for the level to drop below 60dB. The equation is $RT_{60} = 0.161V/A$. RT_{60} is the Reverberation time in seconds, this is the reverb tail. V is volume pressure, which is found by multiplying the room's dimensions (Figure 7). A is absorption coefficients of the surface's materials (Figure 8). The calculation for $RT_{60,}$ is categorize in to bands of frequencies; 125Hz, 250Hz, 500Hz, 1000Hz, 2000Hz and 4000Hz. (Everest, 2014) (Acousticfields, 2015)



L		W		H		cu.ft.	m³
10′	3.04m	9′	2.43m	11′	3.35m	990	28.03
24′	7.31m	23′	7.01m	11′	3.35m	6072	171.93

Figure 7 Bad Room Volume, Good Room Volume.



Surface	S (m3)	a	Sa
Wall 1(w)	47.128	0.2	9.4256
Wall 2(w)	47.128	0.2	9.4256
Wall 3(L)	69.914	0.04	2.80
Wall 4(L)	73.874	0.04	2.95496
Ceiling	188.2928	0.42	79.08298
Floor	188.2928	0.02	3.765856
Door	3.96	0.35	1.386
Absorbers	60	0.35	21
People	250	0.33	82.5
Total			212.34

Figure 8 Absorption for each surface

this is simple to calculate but can be complicated. As there could be noise within the room, meaning the source needs to be louder. Everest (2014, pp.156) states, "If the background noise level is 30dB, the source levels will need to be 100dB, which is attainable. However, if the noise level is near 60dB, a source level greater than 120dB is required." (Figure 9)

Which means the source needs to be 60dB louder. Issues can occur with wattage, as doubling the wattage only increases the decibels by 3, 100Watt = 100dB, 200Watt = 103dB (Everest, 2014)

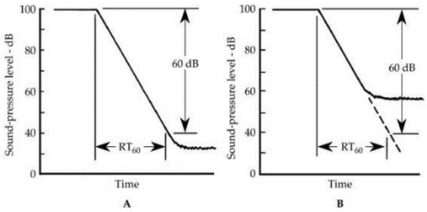


Figure 9 Signal-to-noise ratio

Another way is the $T^{20/30}$ equations. T^{20} is very similar to RT^{60} but it looks at the first 20dB decay, and then estimating the rest of the drop. T^{30} being 30dB instead. (Figure 10) (Cox, 2016)

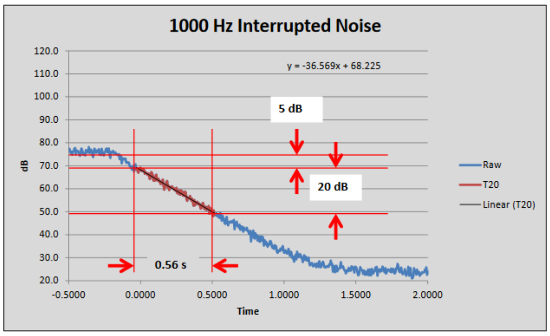
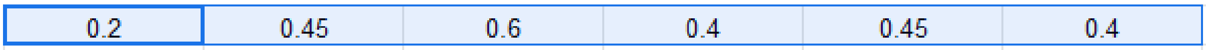


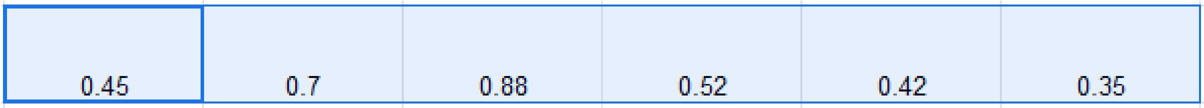
Figure 10 $T^{20/30}$ Equation

Metronome’s Volume and Absorption can be calculated to find the Reverberation Time. V is *17.18m*10.96m*4.3m = 809.659V*. To get the absorption, materials will be chosen for each surface; For the walls, Breeze Block (Figure 11). 12% perforated plaster tiles, absorbent felt glued to back, 200mm ceiling void for the ceiling (Figure 12). For the floor a Parquet fixed in asphalt, on concrete (Figure 13). For the door an acoustic door, steel frame, double seals, absorbent in air space (Figure 14).



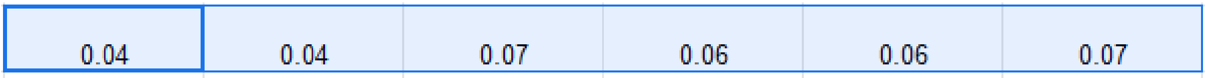
0.2	0.45	0.6	0.4	0.45	0.4

Figure 11 Breeze Block Absorption coefficients



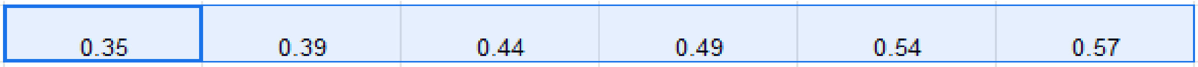
0.45	0.7	0.88	0.52	0.42	0.35

Figure 12 12% perforated plaster tiles, absorbent felt glued to back, 200mm ceiling void



0.04	0.04	0.07	0.06	0.06	0.07

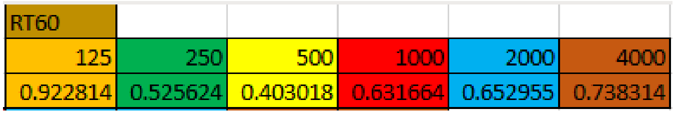
Figure 13 Parquet fixed in asphalt, on concrete Absorption coefficients



0.35	0.39	0.44	0.49	0.54	0.57

Figure 14 Acoustic Door, Steel Frame, Double Seals, Absorbent in air space. Absorption coefficients

The room’s RT^{60} is at a good start, most of the frequency bands are below 0.8 seconds without absorbers/diffusers but 125Hz is bad as it just over 0.9 seconds. (Figure, 15)



RT60					
125	250	500	1000	2000	4000
0.922814	0.525624	0.403018	0.631664	0.652955	0.738314

Figure 15 RT^{60} Results with no absorption

Venues that play amplified music want low reverberation time, under a second. Low end instruments like the kick drum and bass guitar want a low reverb time as 125Hz/500Hz bandwidths ruin the sound if the reverb time is long. (Stofringsdal, 2013). (Everest, 2014)

4. Absorption/Diffusion Placement

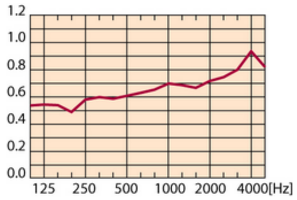


Figure 16 Alpha S Coefficients

Two versions of the Slotted Acoustic Wood Planks will be used on ceiling, Alpha S Type 16 with 30mm, 366mm Depth and Alpha P Type 6 with 30mm insulation with 46 mm Depth as Alpha S has a constant coefficients and builds towards 4000Hz but drop at 200Hz. (Figure 16) (RPGEurope, 2019)

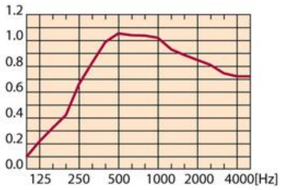


Figure 17 Alpha P Coefficients

Alpha P is worse below 250Hz but above it has superior absorption, its coefficients is above 0.8a at 275Hz and raises to 1.0a at 500Hz then steadily drops to 0.7a at 4000Hz. (Figure 17) (RPGEurope, 2019) an even amount of Alpha S and Alpha P will be distributed. (Figure 18)

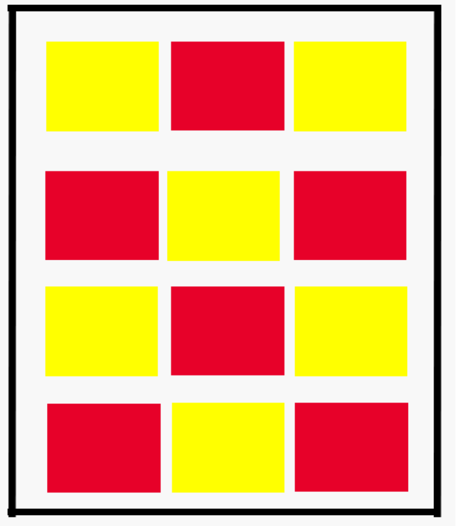


Figure 18 Alpha S and P placements (NOT TO SIZE OR ACCURATE)

The ceiling absorbers will be tilted as since they are wood, they will reflect with the floor and create flutter echoes. (Everest, 2014)

Abffusor and Flutterfree will be used on the walls and doors. As the Flutterfree has excellent coefficients of 0.8a from 200Hz then drops to 0.4a at 400Hz, and the other bandwidths are constantly 0.2a. (Figure 19) (RPGEurope, 2019)

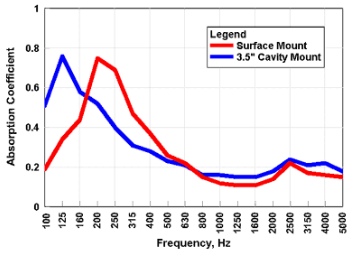


Figure 19 Flutterfree Coefficients (Surface Mount)

Abffusor's coefficients is being used for its high frequency, from 400Hz/4000Hz it has a constant coefficients above 1.0a. While 125Hz/400Hz it climbs from 0.4a. (Figure 20) (RPGEurope, 2019)

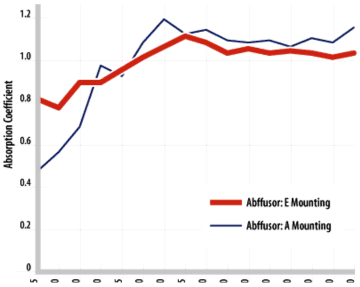


Figure 20 Abffusor Coefficients (A Mounting)

An even placement will be on the walls, both flutter echoes will have a Flutterfree placed there, as they are designed for Flutter Echoes. (Figure 21) (RPGEurope, 2019)

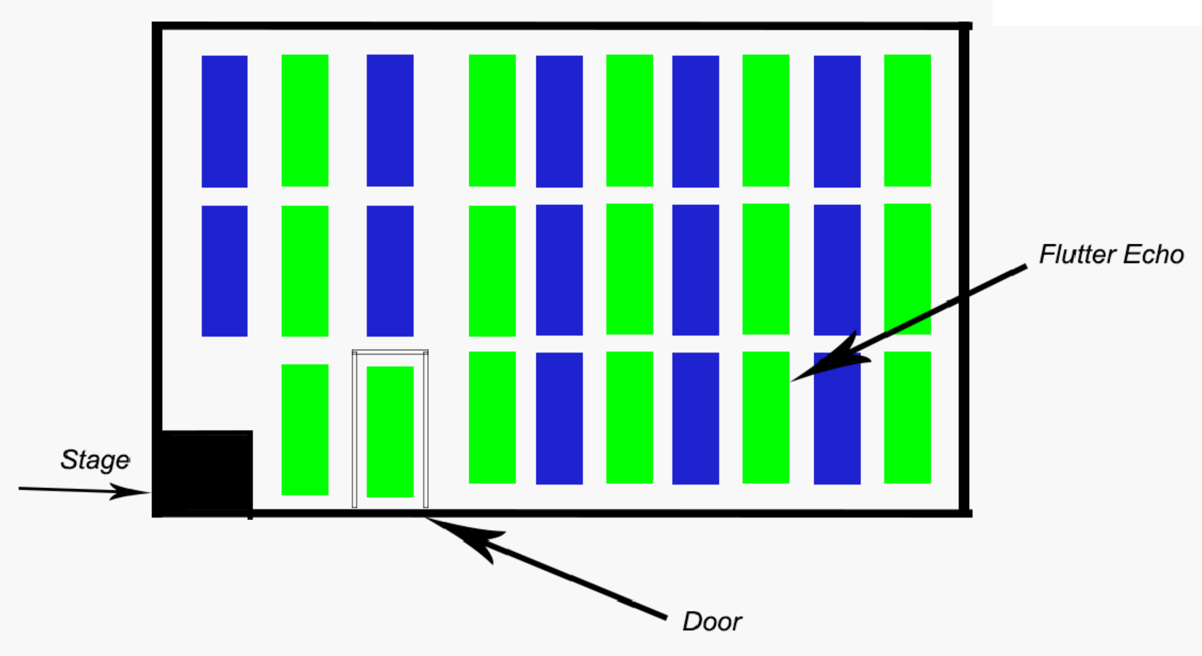
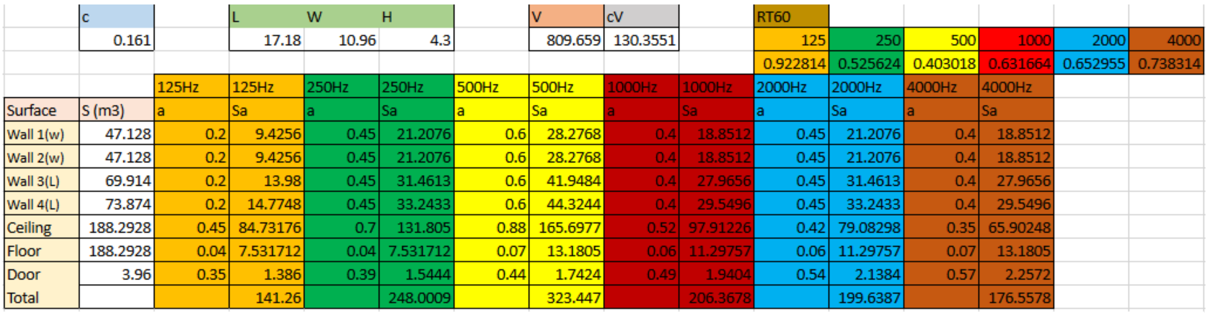


Figure 21 Flutterfree & Abffusor placement/ Flutter Echo removal. (NOT TO SIZE OR ACCURATE)

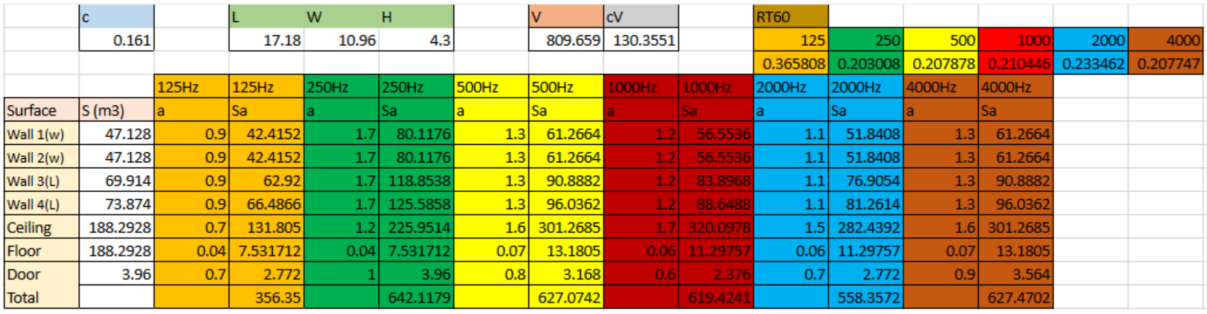
(Figure 22) Shows the room before the acoustical treatment. The reverberation time was already great, with everything other than 125Hz and 4000Hz being low. As stated before, 125Hz to 500Hz needs a low reverberation. (Stofringsdal, 2013).



	c		L	W	H		V	cV		RT60					
	0.161		17.18	10.96	4.3		809.659	130.3551		125	250	500	1000	2000	4000
										0.922814	0.525624	0.403018	0.631664	0.652955	0.738314
		125Hz	125Hz	250Hz	250Hz	500Hz	500Hz	1000Hz	1000Hz	2000Hz	2000Hz	4000Hz	4000Hz		
Surface	S (m3)	a	Sa	a	Sa	a	Sa	a	Sa	a	Sa	a	Sa		
Wall 1(w)	47.128	0.2	9.4256	0.45	21.2076	0.6	28.2768	0.4	18.8512	0.45	21.2076	0.4	18.8512		
Wall 2(w)	47.128	0.2	9.4256	0.45	21.2076	0.6	28.2768	0.4	18.8512	0.45	21.2076	0.4	18.8512		
Wall 3(L)	69.914	0.2	13.98	0.45	31.4613	0.6	41.9484	0.4	27.9656	0.45	31.4613	0.4	27.9656		
Wall 4(L)	73.874	0.2	14.7748	0.45	33.2433	0.6	44.3244	0.4	29.5496	0.45	33.2433	0.4	29.5496		
Ceiling	188.2928	0.45	84.73176	0.7	131.805	0.88	165.6977	0.52	97.91226	0.42	79.08298	0.35	65.90248		
Floor	188.2928	0.04	7.531712	0.04	7.531712	0.07	13.1805	0.06	11.29757	0.06	11.29757	0.07	13.1805		
Door	3.96	0.35	1.386	0.39	1.5444	0.44	1.7424	0.49	1.9404	0.54	2.1384	0.57	2.2572		
Total			141.26		248.0009		323.447		206.3678		199.6387		176.5578		

Figure 22 Metronome before Treatment

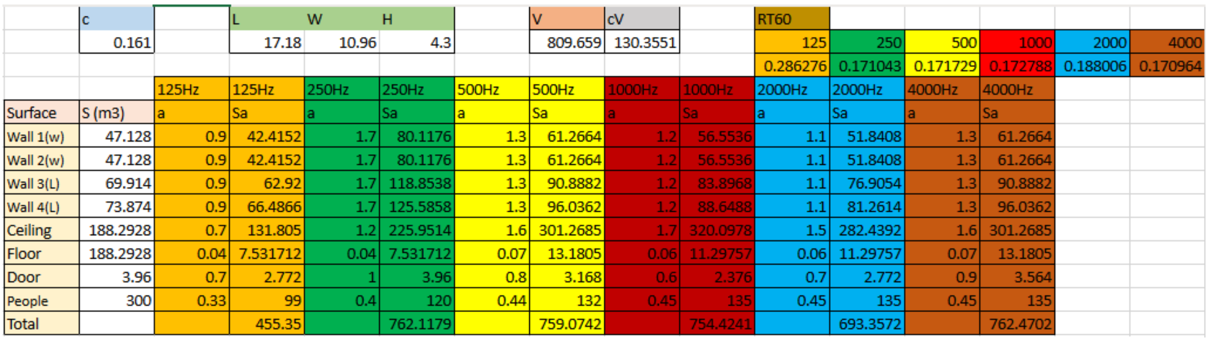
(Figure 23) Shows the room after treatment, the decrease in reverberation time has been substantial, each frequency bandwidth has decreased by more than half. And the issue with the 125Hz bandwidth has been corrected.



	c		L	W	H		V	cV		RT60					
	0.161		17.18	10.96	4.3		809.659	130.3551		125	250	500	1000	2000	4000
										0.365808	0.203008	0.207878	0.210446	0.233462	0.207747
		125Hz	125Hz	250Hz	250Hz	500Hz	500Hz	1000Hz	1000Hz	2000Hz	2000Hz	4000Hz	4000Hz		
Surface	S (m3)	a	Sa	a	Sa	a	Sa	a	Sa	a	Sa	a	Sa		
Wall 1(w)	47.128	0.9	42.4152	1.7	80.1176	1.3	61.2664	1.2	56.5536	1.1	51.8408	1.3	61.2664		
Wall 2(w)	47.128	0.9	42.4152	1.7	80.1176	1.3	61.2664	1.2	56.5536	1.1	51.8408	1.3	61.2664		
Wall 3(L)	69.914	0.9	62.92	1.7	118.8538	1.3	90.8882	1.2	83.8968	1.1	76.9054	1.3	90.8882		
Wall 4(L)	73.874	0.9	66.4866	1.7	125.5858	1.3	96.0362	1.2	88.6488	1.1	81.2614	1.3	96.0362		
Ceiling	188.2928	0.7	131.805	1.2	225.9514	1.6	301.2685	1.7	320.0978	1.5	282.4392	1.6	301.2685		
Floor	188.2928	0.04	7.531712	0.04	7.531712	0.07	13.1805	0.06	11.29757	0.06	11.29757	0.07	13.1805		
Door	3.96	0.7	2.772	1	3.96	0.8	3.168	0.6	2.376	0.7	2.772	0.9	3.564		
Total			356.35		642.1179		627.0742		619.4241		558.3572		627.4702		

Figure 23 Metronome After Treatment

The people that will occupy the venue will act as absorbers; it is best to know how the room's reverberation time will react to the maximum capacity. (Figure 24)



	c		L	W	H		V	cV		RT60					
	0.161		17.18	10.96	4.3		809.659	130.3551		125	250	500	1000	2000	4000
										0.286276	0.171043	0.171729	0.172788	0.188006	0.170964
		125Hz	125Hz	250Hz	250Hz	500Hz	500Hz	1000Hz	1000Hz	2000Hz	2000Hz	4000Hz	4000Hz		
Surface	S (m3)	a	Sa	a	Sa	a	Sa	a	Sa	a	Sa	a	Sa		
Wall 1(w)	47.128	0.9	42.4152	1.7	80.1176	1.3	61.2664	1.2	56.5536	1.1	51.8408	1.3	61.2664		
Wall 2(w)	47.128	0.9	42.4152	1.7	80.1176	1.3	61.2664	1.2	56.5536	1.1	51.8408	1.3	61.2664		
Wall 3(L)	69.914	0.9	62.92	1.7	118.8538	1.3	90.8882	1.2	83.8968	1.1	76.9054	1.3	90.8882		
Wall 4(L)	73.874	0.9	66.4866	1.7	125.5858	1.3	96.0362	1.2	88.6488	1.1	81.2614	1.3	96.0362		
Ceiling	188.2928	0.7	131.805	1.2	225.9514	1.6	301.2685	1.7	320.0978	1.5	282.4392	1.6	301.2685		
Floor	188.2928	0.04	7.531712	0.04	7.531712	0.07	13.1805	0.06	11.29757	0.06	11.29757	0.07	13.1805		
Door	3.96	0.7	2.772	1	3.96	0.8	3.168	0.6	2.376	0.7	2.772	0.9	3.564		
People	300	0.33	99	0.4	120	0.44	132	0.45	135	0.45	135	0.45	135		
Total			455.35		762.1179		759.0742		754.4241		693.3572		762.4702		

Figure 24 Metronome After Treatment with Maximum Capacity

The addition of people in Metronome decreases the average reverberation by 0.04459sec. This helps making the room sound clear and more controlled.

5. Sound System Design

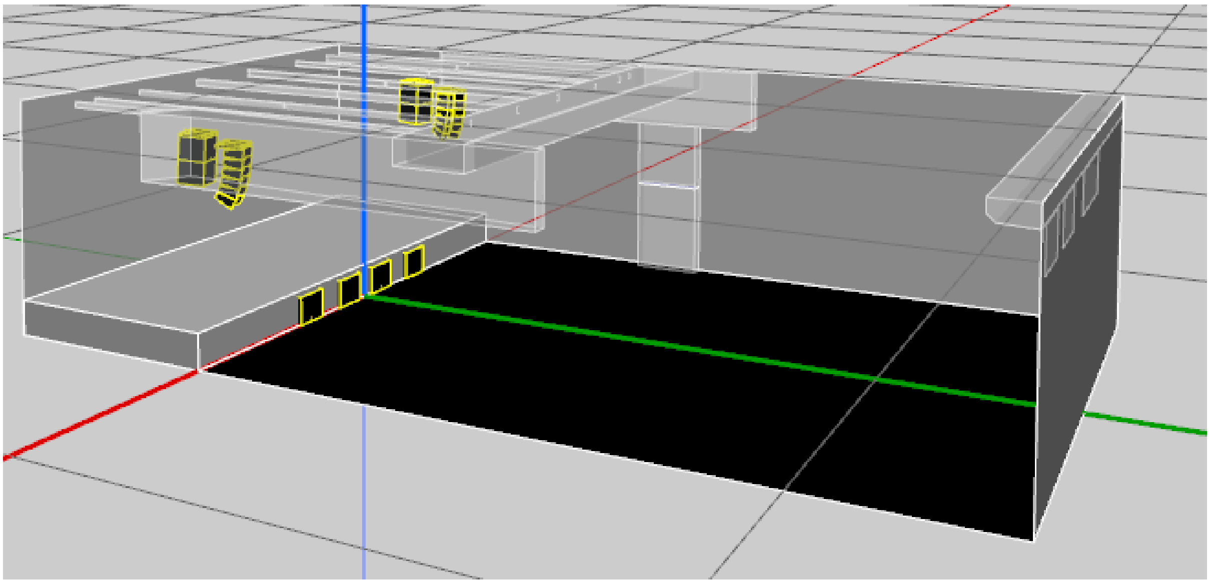


Figure 25 speaker positioning. Speaker Height

When positioning the Speaker system, somethings should be considered. (Figure 25)
Height of the Line Arrays, this should be considered as Carpenter (2013, 1:18sec) states, “I can always lower the PA to match what I needed to do in the room, but if I don’t have the height, I can’t create energy this way. I can’t make it go higher than the hook is. I only go lower than the hook.”

Depending on the dimensions of the venue, the line array will be positioned differently. As shown earlier, shoebox rooms tend to lose sound at the back wall. (Everest, 2014) To get the most coverage, the line array system in metronome will be as high as possible. (Carpenter, 2013) (Figure 25)

Angling individual speakers of the line array, the top speaker will reach the back wall while the bottom speakers will reach the front of the floor. The speakers in-between are there to address everything between the back and front. When angling them an even spread of the sound is the goal. (Carpenter, 2013)

The process of choosing speaker systems is vital, depending on what is chosen will have an impact on the quality in the room. To simplify the process, the selection found on the L-Acoustic’s website will be used.

The speakers that will be compared: Kiva II and Kara, both are Line Array type speakers. The frequency bandwidth of each is not very different, as the Kara goes as low as 55Hz while Kiva can manage 70Hz. Both can product the full range past those points. It is not significant as these will not be used for low end frequencies.

The Kara has an SPL of 141dB which gives more options on how loud it can be but the pain threshold ranges at 120dB – 140dB so exceeding 140dB could be dangerous. (Everest, 2014) (SCENIHR, 2008) (L-Acoustics, n.d)

The Kara has better impedance, which is the resistance from the speaker, as it is 8Ω less than the Kiva which is 16Ω. Meaning the Kara will have less resistance when receiving the signal from the desk. (L-Acoustic, n.d) (Audiogurus, 2018)

(Figure 26) Shows the Kiva II has good coverage, there is no place within the room that drops below 102dB. The front floor has a coverage of 108dB. The room is consistent in its volume. However, it has a strip in the centre that is 111dB, which compared to the back parts of the room would be noticeable.

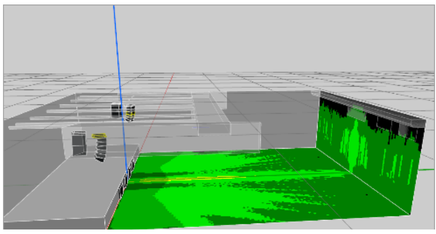


Figure 26 Kiva II's Coverage

(Figure 27) Is not much different in terms of coverage, but it is louder, as the coverage is 111dB. The front floor goes up to 114dB. Kara's coverage has an issue of being consistent at the back wall as it drops to 108dB. To improve this issue the angling of the Line Arrays. (Carpenter, 2013)

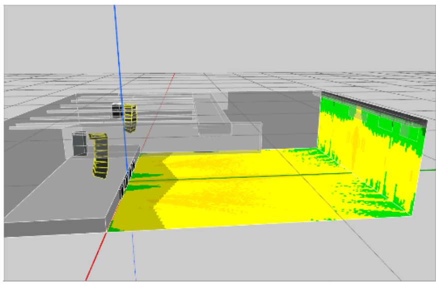


Figure 27 Kara's Coverage

By angling the speakers, (Figure 28) the coverage improves by moving the top speaker latch. Now the room has no substantial drop in volume. (Carpenter, 2013)

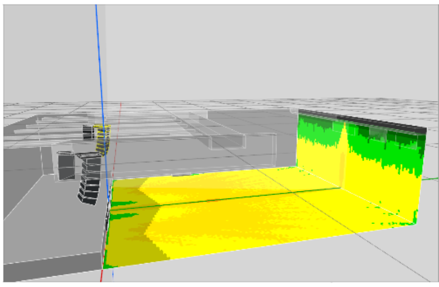


Figure 28 Kara Improved Coverage

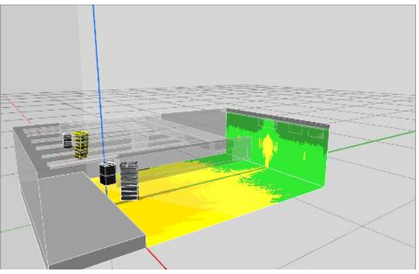


Figure 30 Coverage response FOP

Metronome's dimensions do not work with first-order plateau as the speakers face the walls, meaning the back wall is receiving reflections thus making the back quieter (Figure 29) (McCarthy, 2016) (Figure 30) (McCarthy, 2016)

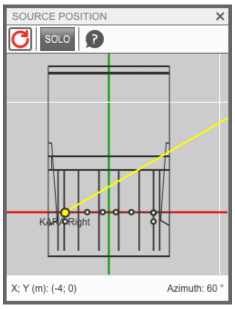


Figure 29 First-Order Plateau (>60º)

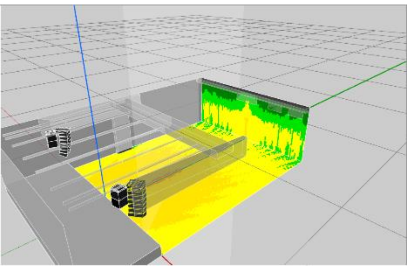


Figure 32 Coverage response SOP

This directivity works against the shoebox shape, a wider directivity will be used.

The second-order plateau fits this design, as it ranges between 20º to -60º. The degrees 36.6º works as this faces the speakers towards the back corners of the room. (Figure 31) (McCarthy, 2016)

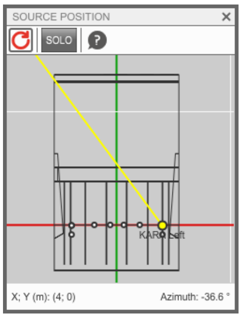


Figure 31 Second-Order Plateau (20 -60º)

This directivity gives the back wall near-equal coverage with the front floor. Compared to (Figure 30) the coverage is better, but still suffers from not completely covering the floor. (McCarthy, 2016) (Figure 32)

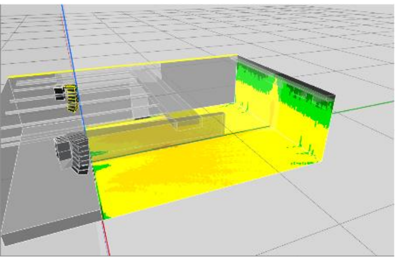
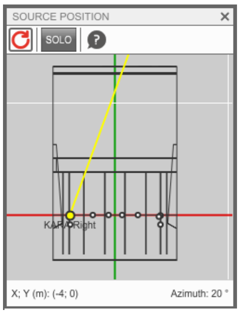


Figure 34 Coverage response TOPB

Third-order proportional beamwidth (<20º) will be used as it was designed with multiple speakers in mind and coupled speakers. 20º gives the best coverage, (Figure 33) as the back wall is completely covered other than the back corners. To correct this, the degrees could be lower, but means the front floor will drop in decibel as well. (Figure 34) (Figure 35) (McCarthy, 2016)



X; Y (m): (-4; 0)

Azimuth: 20 °

Figure 33 Third-order proportional beamwidth (<20º)

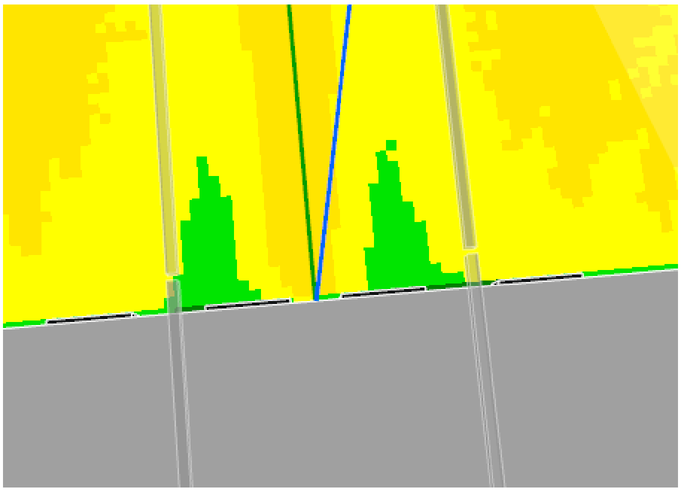


Figure 35 decibel loss at front floor

Crossovers are applied to speakers to get the most efficiency, these crossovers are filters, so a tweeter will have a high pass filter and the woofer will have a low pass filter. (McCarthy, 2016)

These filters are called RC Filters, there are two types of these filters. Passive filters do not need an external power supply while active filters do.

Coils and capacitors are what create the filters, they do this after amplification, and they separate the frequencies in to their respective drivers in passive filters. Active filters do the filtering before amplification, thus needing one amplifier channel per loudspeaker network, each frequency bandwidth needs an amplifier. Passive filters are cheaper, but they lack the ability to tweak the filters, while active filters offer this ability. Active filters are superior for their ability to change what is needed for the event. (Minidsp, n.d)

High pass filter consists of a capacitor (C) and a resistor (R) (Figure 36). Resistance is a constant at any frequency, but due to the capacitive reactance (X_C) from the capacitor it affects the current flow. The capacitor and resistor are placed on the input and due to the X_C being greater with low frequencies, the output only has high frequencies pass through. Also, due to the resistance from the resistor being a higher value than the X_C, as X_C is lesser at higher frequencies. (Learnabout Electronics, n.d)

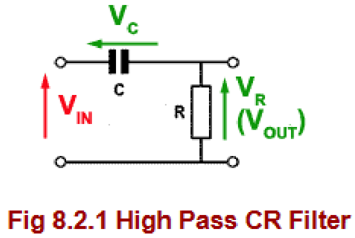


Figure 36 High Pass Filter

Low pass filters have the capacitor and resistor switched (Figure 37), now the low frequencies high reactance from the capacitor lets all the input signal be developed as an output voltage across the X_C. The X_C at higher frequencies becomes far less than the resistor and little input signal is developed across X_C. Which reduces the higher frequencies making a low pass filter. (Learnabout Electronics, n.d)

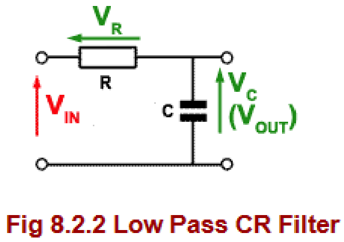


Figure 37 Low Pass Filter

There are different classes of crossovers, the unity is equal to the isolated levels, overlapping is higher than the isolated levels and gapped is lower than the isolated levels. (McCarthy, 2016) (Figure 38)

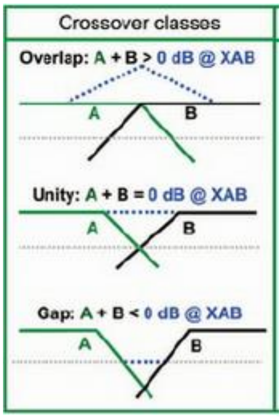


Figure 38 Crossover Classes

An element of loudspeakers are drivers, there different types. Cone Drivers are made of paper/high-tech composites with two surround attachments. The inner surround attaches to the cone’s bottom to control coil movement. The outer surround attaches the top of the cone to the frame. (McCarthy, 2016)

The compression driver packs sound into a small chamber that compresses the air, which then releases it. (McCarthy, 2016)

One of the oldest speaker elements is the horn, which was a funnel combined with a human mouth. Where the name, “Loudspeaker” comes from. (McCarthy, 2016)

Comb Filtering is when a listener is closer to the left speaker, the right speaker will be further away, so the right speaker’s sound will reach the listener after the left speaker, it creates peaks and troughs at certain frequencies. (Everest, 2014) (Figure 39)

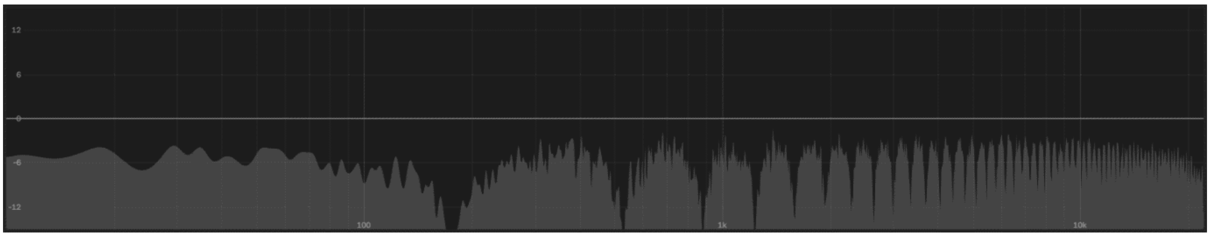


Figure 39 White Noise, peaks and troughs

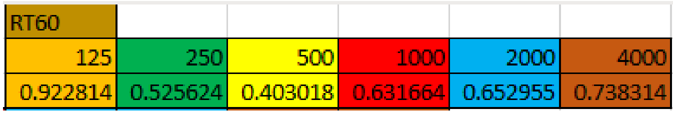
The equation $\sqrt{(1m^2 + 2m^2)} - 2m = Path\ Length$, gives the extra distance the right speaker has to travel compared to the left. The path length of Metronome if positioned 10m away from the Left speaker is 4.8m. The extra time it takes for the right speaker to reach the listener, can be found by *344/Path Length*, which is *0.0140c*.

Then the next equation *1/delay time* gives the fundamental peak, *71.4Hz*. *1/(2*delay time)* gives the fundamental trough, *36.0Hz*. To find the other peaks, adding to the equation *(1/0.0140)*2* gives the second peak, and going up by *1* gives the next, *(1/0.0140)*3,* so forth. This method is used for finding troughs to, *1/(2*0.0140)*3.* But it goes up by *2* instead, *1/(2*0.0140)*5.*

This is different for everywhere in the room. But knowing what the comb filters are in the area the Live Engineer sits, is helpful as then the engineer can work around it. (Everest, 2014)

Conclusion

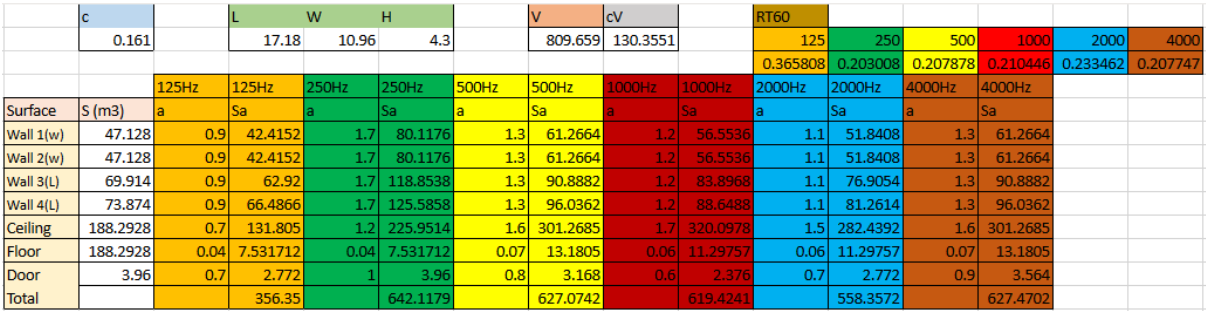
Having a reverberation time at 0.8secs or under was a success. As from the material chosen for the surfaces alone, the reverberation was near the goal. (Figure 40) The only issues left were the 125Hz and 4000Hz



RT60					
125	250	500	1000	2000	4000
0.922814	0.525624	0.403018	0.631664	0.652955	0.738314

Figure 40 Reverberation Time Near Goal, no Absorption

The absorption added to the room had dropped the reverberation time, (Figure 41) each octave was under the goal of 0.8secs. Meaning the venue is suited for amplified music.



	c		L	W	H		V	cV		RT60					
	0.161		17.18	10.96	4.3		809.659	130.3551		125	250	500	1000	2000	4000
										0.365808	0.203008	0.207878	0.210446	0.233462	0.207747
		125Hz	125Hz	250Hz	250Hz	500Hz	500Hz	1000Hz	1000Hz	2000Hz	2000Hz	4000Hz	4000Hz		
Surface	S (m3)	a	Sa	a	Sa	a	Sa	a	Sa	a	Sa	a	Sa		
Wall 1(w)	47.128	0.9	42.4152	1.7	80.1176	1.3	61.2664	1.2	56.5536	1.1	51.8408	1.3	61.2664		
Wall 2(w)	47.128	0.9	42.4152	1.7	80.1176	1.3	61.2664	1.2	56.5536	1.1	51.8408	1.3	61.2664		
Wall 3(L)	69.914	0.9	62.92	1.7	118.8538	1.3	90.8882	1.2	83.8968	1.1	76.9054	1.3	90.8882		
Wall 4(L)	73.874	0.9	66.4866	1.7	125.5858	1.3	96.0362	1.2	88.6488	1.1	81.2614	1.3	96.0362		
Ceiling	188.2928	0.7	131.805	1.2	225.9514	1.6	301.2685	1.7	320.0978	1.5	282.4392	1.6	301.2685		
Floor	188.2928	0.04	7.531712	0.04	7.531712	0.07	13.1805	0.06	11.29757	0.06	11.29757	0.07	13.1805		
Door	3.96	0.7	2.772	1	3.96	0.8	3.168	0.6	2.376	0.7	2.772	0.9	3.564		
Total			356.35		642.1179		627.0742		619.4241		558.3572		627.4702		

Figure 41 RT60 Reverberation Time Surpassing Goal, with Absorption

The absorbers used within Metronome were choosen for their coefficients and to help reduce issues within the room. Flutterfree were chosen for its absorption coefficents and to remove flutter echoes. (Figure 42)

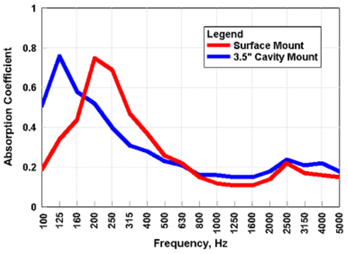


Figure 42 Flutterfree Absorption Coefficients

The absorption coefficents are beneficial for its low end absorption, which is needed to help keep the kick drum and bass clear. And for its propose of removing flutter echoes, which as stated eariler, Metronome has two flutter echoes.

The Kara speaker system fits the goal. The SPL is 141dB which is too loud but more options of level are available. A benefit of the higher SPL, is the coverage. (Figure 43)

The average level of the coverage is 111dB, which is 4dB higher than the recommended 107dB by the HSE, but it can be reduced to 107dB. (HSE, n.d)

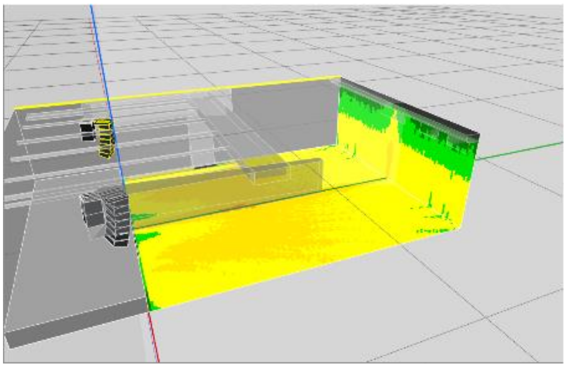


Figure 43 Kara Coverage

Understanding issues and correcting/reducing them is a success, as this report covers room shapes and their characteristics, flutter echoes and how to remove them.

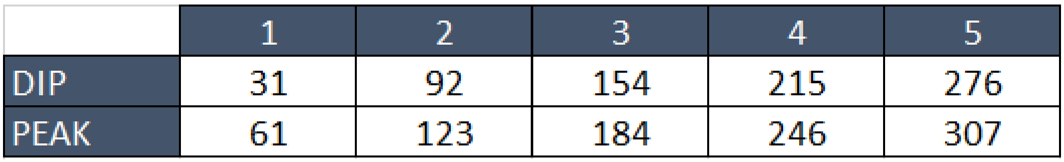
Being able to understand the frequnecy response with Schroeder frequency, Metronomes SF being 42.5Hz and using equalization to correct peaks and troughs.

How to deal with noise when calculating RT^{60}, using $T^{20/30}$ equations. Metronomes does not suffer with noise, the RT^{60} was used.

How to get better coverage with directivity of speakers, the speakers have been set to 20º which is in the Third-order proportional beamwidth range.

Understanding the propose of crossover on speakers, low/high pass filters and different kinds of crossovers, unity, overlapping and gapped.

What comb filtering is and how to calculate that so the live engineer can accommodate. (Figure 44) shows the comb filter data when in the Live Engineer position in Metronome.



	1	2	3	4	5
DIP	31	92	154	215	276
PEAK	61	123	184	246	307

Figure 44 Comb Filter Data

Comb filtering is one of the significant elements of this report. It is something that can not be corrected. It is an occurrence that affects every where in the room differently. The only method to help with it, is knowing the comb filtering in the live engineer position so they can make a mix with that in mind.

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