SECTION SEVEN | Acoustics

Acoustics is an important but often overlooked element of architectural design. In certain cases, a poor acoustical design can ruin an otherwise well designed space. For the August Wilson Center, acoustics is certainly paramount. As a center for arts and culture, the center will be home to a variety of acoustical situations from spoken word performances to small recitals to lectures to full theatrical performances. For this analysis, two of the critical spaces were selected, analyzed, and if necessary, redesigned. Detailed calculations of reverberation time and sound transmission coefficients (STC) were used to make conclusions about the acoustical effectiveness of the designs.

1. THE MUSIC CAFÉ

The Music Café is characterized by Perkins + Will as follows:

> *The café is located at sidewalk level, accessible directly from the street and from within the center. It will function as a traditional museum café and sidewalk café during the day. A seating terrace is located outside and adjacent to the café. Wired for internet access and designed to accommodate a wide range of emerging technologies, the Café provides an electronic link to visitors worldwide.*
>
> *Modeled after New York's BAM café or Joe's Pub the Café is also designed to accommodate an on-going menu of programs and to function as an alternative performance space for intimate performances with limited seating for jazz, spoken word, poetry and other new performance forms in a club setting at night. A portable stage and theatrical lighting will be imported to support such performances as required.*

This space is essential a large rectangular box with three glass sides, a hard floor, and sound absorbing treatment on the ceiling (although behind baffles and ductwork). It is evident design does recognizes the need for acoustical design elements, with hanging metal baffles and acoustical blanket over 80% of the underside of the floor structure above.

Based on the use description provided by the architect, a reverberation time of approximately 1.0 second would be ideal. This would place the space somewhere between speech and speech/music use. According to the *Architectural Acoustics: Principles and Design* a very high STC value (60+) between the Music Café and lobby would be desirable. This is important to both spaces, as a spoken word performance in the café could suffer if a large crowd was gathering in the lobby for a performance in the main theater, while the lobby must remain quiet during a performance in the main theater if patrons are entering or exiting the auditorium since a main set of doors is directly across from the café.

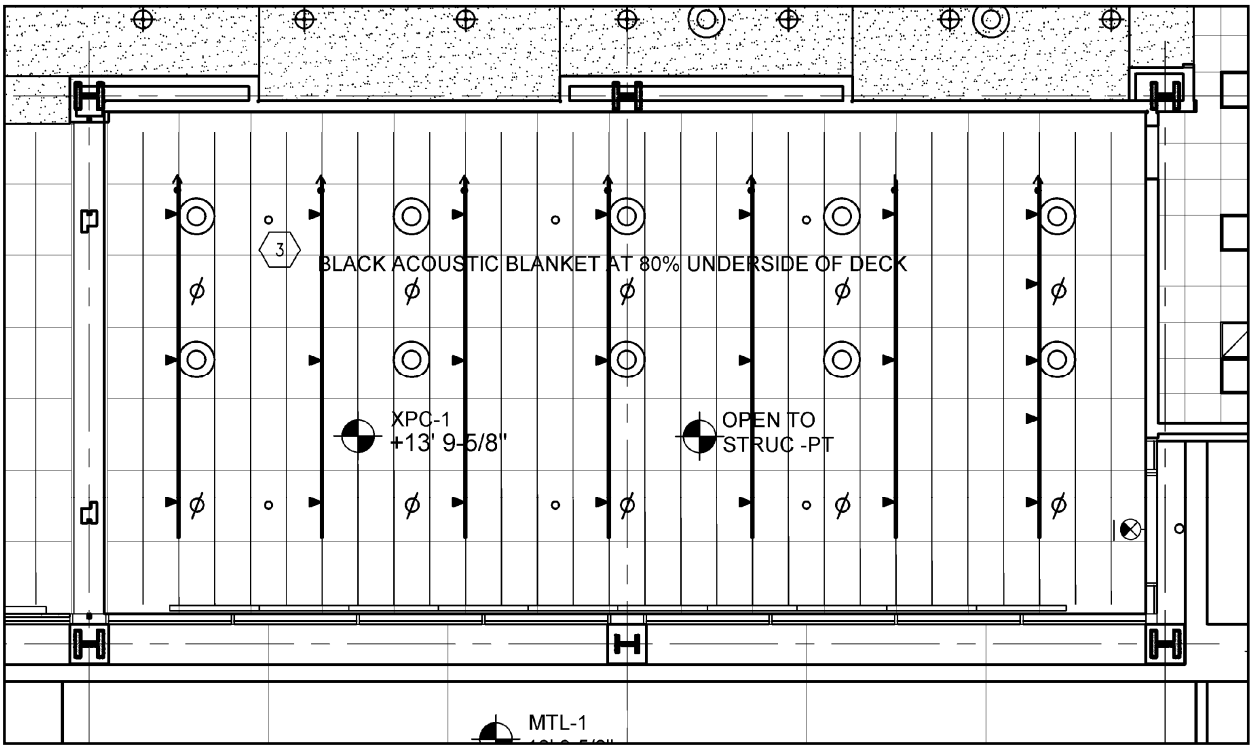

Figure 7.1.1 | Music Café Reflected Ceiling Plan – Existing Design [Not to Scale]

REVERBERATION TIME SUMMARY: MUSIC CAFÉ (EXISTING)						
Freq. (Hz.)	125	250	500	1000	2000	4000
T_{60} =	**1.677**	**2.596**	**0.801**	**0.798**	**0.807**	**0.752**

Figure 7.1.2 | Music Café Reverberation Time – Existing Design. Full calculation available in Appendix J.

Figure 7.1.2 illustrates that the existing reverberation times are far from ideal. One important consideration, however, is that the manufacturer of the metal baffle ceiling system (Chicago Metallic) does not have acoustical data for the product. Therefore, the product has been omitted from the calculations. Including the baffles in the calculation would likely reduce the very high reverberation times at the lower frequencies, but it would also reduce the reverberation times at the higher frequencies which are already lower than ideal.

Additional analysis of the sound transmission class (STC) on the wall between the café and the main lobby reveals a potential for unwanted noise transfer between the spaces. At 46, the calculated STC falls far below the ideal value of 60+ (See Appendix J for STC calculations). This problem is generated by the use of glass doors and partitions between the spaces. Changing the glass type from ½" tempered glass to ½" laminated glass improves the STC to 49, but this is only a marginal increase. To really improve this potentially negative situation, significant changes to the architecture are required. These changes may include changing the glass to another material such as wood or creating a small vestibule at the entrances. These changes, however, would significantly alter the architecture. It would be appropriate to point out the problem to the architect, but it is unlikely that the changes would be made.

Improving the reverberation time is a much more realistic change. In order to do this, I have eliminated the metal baffles and acoustical blanket, replacing them with floating fiberglass sound absorbing panels that are faced in perforated metal (See Appendix K for product specifications). This product is pictured in Figure 7.1.3. This change will most likely reduce cost by replacing two materials with one. Some changes were necessary in the location and type of HVAC diffusers and sprinkler heads. However, these changes should not require significant changes to the overall system. Figure 7.1.5 shows the new reverberation times based on 900 square feet of the new acoustical panels. Figure 7.1.4 shows the proposed layout of these panels.

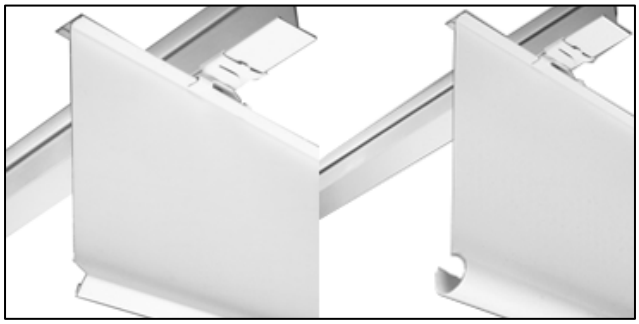

Figure 7.1.3|Left: Alpro Metal Acoustical Baffles for the new design. (www.alproacoustics.com) Above: Existing hanging metal baffle system from Chicago Metallic.

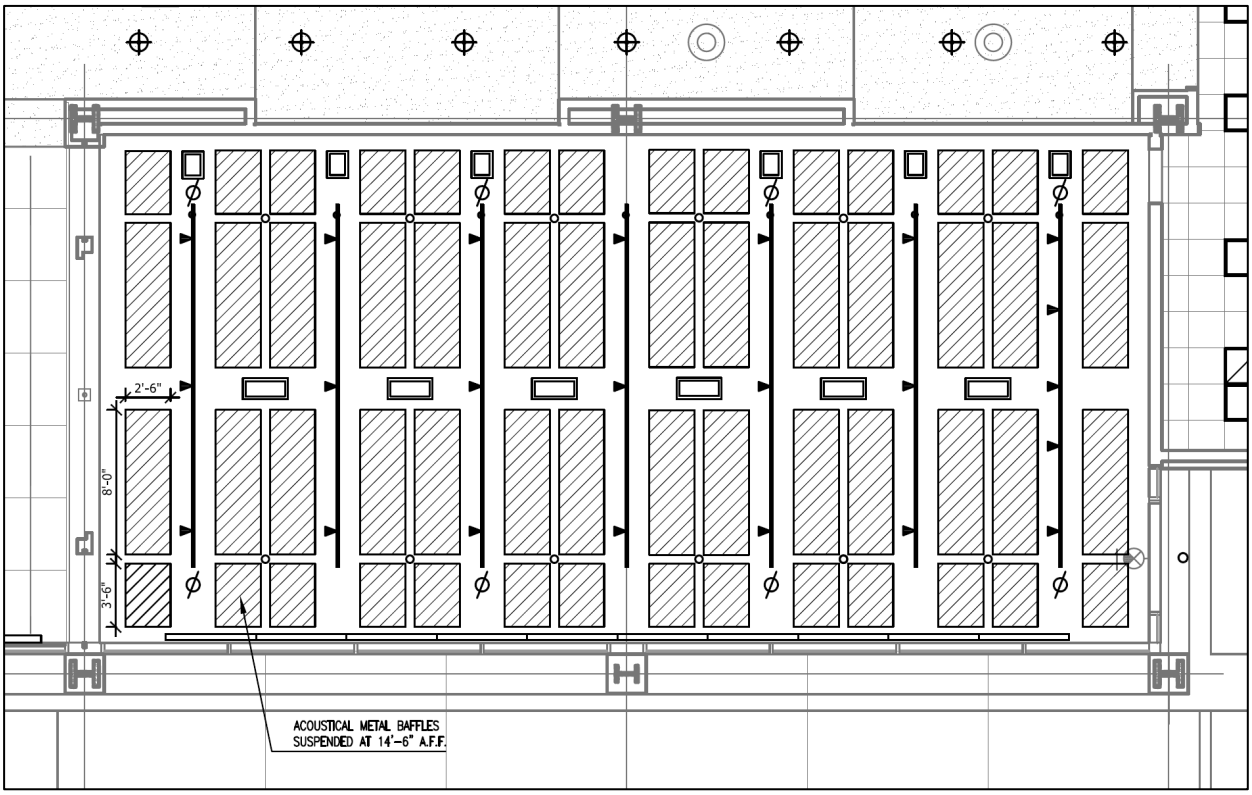

Figure 7.1.4| Music Café Reflected Ceiling Plan – New Design

REVERBERATION TIME SUMMARY: MUSIC CAFÉ (NEW)						
Freq. (Hz.)	125	250	500	1000	2000	4000
T_{60} =	**1.620**	**1.243**	**0.984**	**1.054**	**1.077**	**1.065**

Figure 7.1.5 | Music Café Reverberation Time – New Design. Full calculation available in Appendix J.

BAFFLES - MUSIC CAFE			
TAG	**QUANTITY**	**LENGTH (FT)**	**WIDTH (FT)**
PANEL TYPE A	28	8'-0"	2'-6"
PANEL TYPE B	28	3'-6"	2'-6"

Figure 7.1.6 | Music Café New Baffle Schedule of Materials

The new reverberation times are very close to the desired values. According to *Architectural Acoustics: Principles and Design* optimum reverberation times at 125 hertz should be 1.3 times the ideal reverberation time at 500 hertz and a multiplier of 1.15 should be used at 250 hertz. These multipliers are used to correct for the fact that the human ear is less sensitive at lower frequencies. With these factors included, the new design is very near the target. The new ceiling system will provide superior acoustical performance at a reduced cost.

2. MULTIPURPOSE ROOM

The multipurpose room is characterized by Perkins + Will as follows:

> *Located at the second level, the multipurpose room functions as a flexible performance space and with its sprung hardwood floors also serves as the Center's rehearsal hall. It will be available for programming of special events including dance parties and social events such as weddings, fundraisers, birthday parties and other celebrations. Theatrical lighting and sound systems, portable stage and portable practice bar can be imported as required per activity requirements. The room benefits from significant daylighting due to large areas of north facing windows overlooking Liberty Avenue and can also be fully darkened.*

Based on the description from Perkins + Will, this will be a very dynamic space with a variety of uses. This makes acoustical design more complex. A reverberation time of 1.2 seconds would satisfy the majority of uses for this space.

The construction and materials of the multipurpose room are the same as the Music Café with the exception of the ceiling. In this space, the ceiling is completely open to the underside of the floor decking, which is fully covered in black acoustical blanket, and a theatrical style steel pipe grid is suspended at 19'-6". Additionally, a gypsum soffit forms the ceiling where the room cantilevers out beyond the rest of the structure. The space is also 20% higher, 24.5' compared to 19.5', compared to the Music Café. The increased volume changes the acoustical properties of the space, requiring slightly different amounts of absorbing materials. The figures below show the existing reflected ceiling plan and reverberation times.

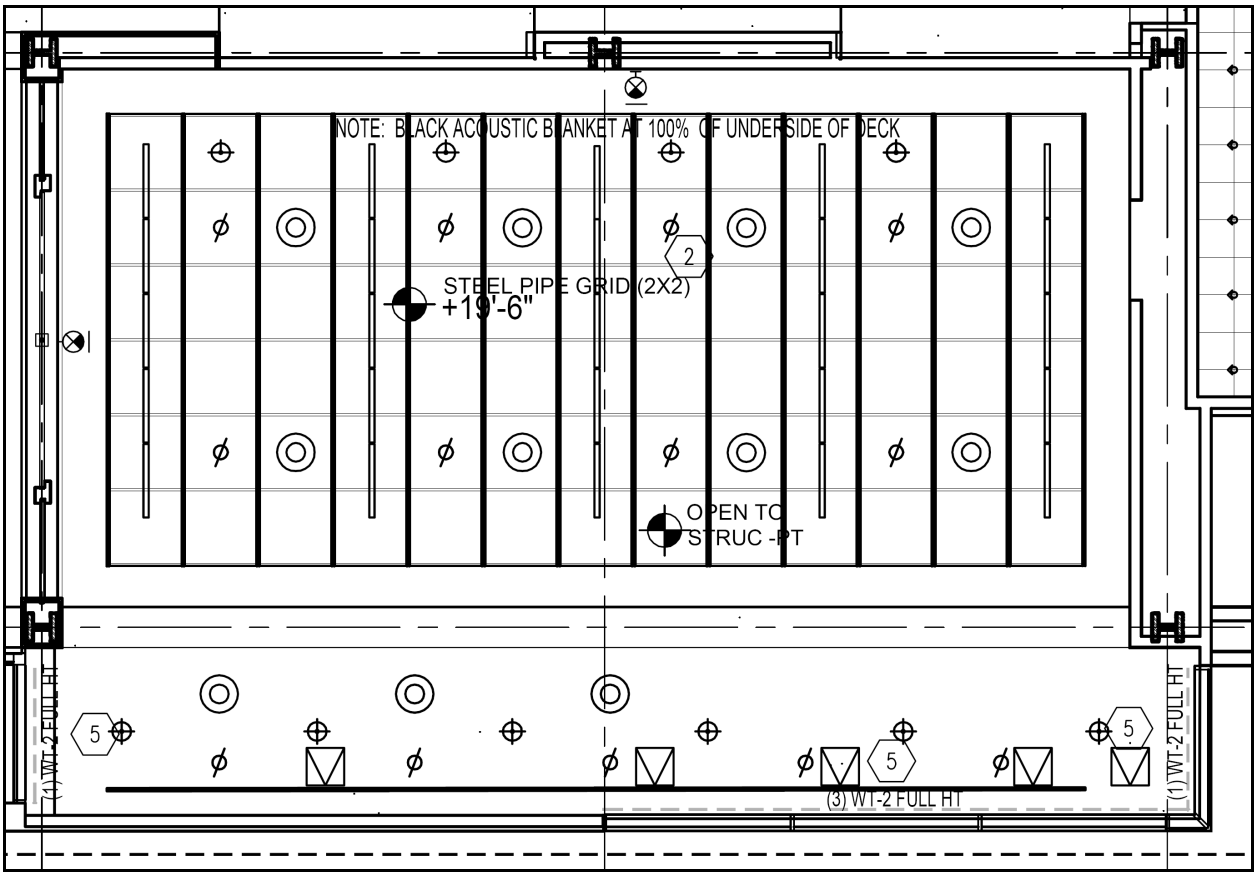

Figure 7.2.1 | Multi Purpose Room Reflected Ceiling Plan – Existing Design [Not to Scale]

REVERBERATION TIME SUMMARY: MULTI-PURPOSE (EXISTING)						
Freq. (Hz.)	125	250	500	1000	2000	4000
T_{60} =	**1.732**	**2.471**	**1.011**	**1.036**	**1.042**	**0.941**

Figure 7.2.2 | Multi Purpose Room Reverberation Time – Existing Design. Full calculation available in Appendix J.

The redesign for the multipurpose room works with the pipe grid design to achieve improved acoustical performance. The new design uses the previous identified metal faced baffle panels at the perimeter of the space to avoid interfering with the pipe grid which remains at the center of the room, although slighting reduced in size. The new design incorporates the new lighting design. Some of the diffusers and sprinklers were shifted slightly, but this should not be a serious concern.

To achieve the improved reverberation time, some of the black acoustical blanket remains, covering the area above the pipe grid. The combination and layout of materials gives the room a more interesting appearance while improving acoustical conditions. Thus, it is a win-win situation. Similar to the improvements made in the Music Café, the reverberation times were evened across the frequency spectrum and are very close to the desired values.

A new reflected ceiling plan and summary of the new reverberation times are shown below. A schedule of materials for the panels is also provided.

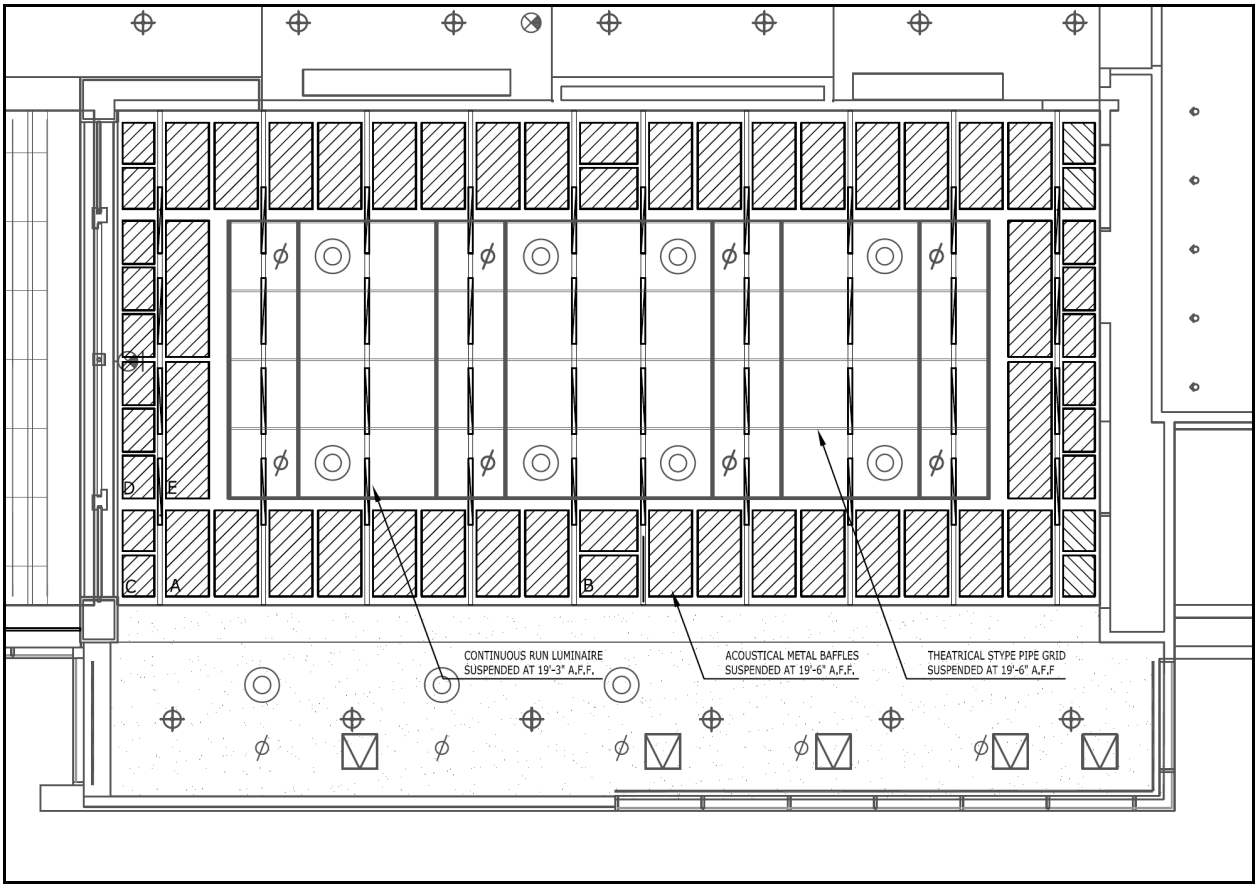

Figure 7.2.3 | Multi Purpose Room Reflected Ceiling Plan – Existing Design (Not To Scale)

REVERBERATION TIME SUMMARY: MULTI-PURPOSE (NEW)						
Freq. (Hz.)	125	250	500	1000	2000	4000
T_{60} =	**1.714**	**1.723**	**1.122**	**1.200**	**1.213**	**1.120**

Figure 7.2.4 | Multi Purpose Room Reverberation Time – Existing Design. Full calculation available in Appendix J.

BAFFLES - MULTI-PURPOSE ROOM			
TAG	**QUANTITY**	**LENGTH (FT)**	**WIDTH (FT)**
PANEL TYPE A	32	5'-0"	2'-6"
PANEL TYPE B	4	3'-4"	2'-4.5"
PANEL TYPE C	8	1'-10"	2'-4.5"
PANEL TYPE D	12	1'-10"	2'-6"
PANEL TYPE E	4	7'-11"	2'-6"

Figure 7.2.5 | Multi Purpose Room - New Baffles Schedule of Materials