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Making it Sound as Good as it Tastes: Noise Reverberation Reduction in a Micro Distillery Tasting Room

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Abstract

Noise reverberation in micro distillery tasting rooms can interfere with speech communication and negatively impact the acoustic quality of live music. Noise reverberation was characterized in a tasting room in Butte, MT by calculated and quantified methods. Sound absorbing baffles were then installed in an effort to reduce reverberation and improve room acoustics. The overall reverberation time and speech interference level were decreased by measureable amounts that corresponded with an increase in overall absorption in the space. Reverberation time decreased from 0.85 seconds to 0.49 seconds on average. As shown by a customer survey given before and after the installation, the customer experience was also improved as a result of the sound absorbing baffles. Other distilleries or breweries may benefit by applying similar sound reverberation assessment and control methods in spaces where customers frequent.

Tasting rooms and brewery taprooms are popular social gathering locations in early evenings and especially on weekends. Many of these facilities also function as live music venues. Current design trends in these spaces are ‘open-concept’ with numerous windows and hard wood or tile flooring. Without carpeting, drapery, and tablecloths that have traditionally dampened noise in lounges and bars, modern spaces have generally become more reflective to sound waves which then makes conversation and music less audibly appealing. Noise reverberation is defined as the overall collection of reflected sounds in a room. Sound reflective surfaces increase the time for generated sound waves to decay in a space, an echo that results can interfere with potential speech communication and create music “blending” issues. This is similar in effect to an echo in a larger church or even a canyon, but on a smaller scale that echo is jumbled and results in a subjectively worse listening experience.

The tasting room for Headframe Spirits has become a social center for uptown Butte, MT. The tasting room is used as a music venue four nights a week and can accommodate over 100 patrons when at capacity. Acoustic problems have been a source of customer complaints to the management and staff since the tasting room opened in 2012. The complaints have included speech communication interferences and background noise that detracts from live music (Rosenleif, 2015). The walls, floors, and ceiling of this tasting room are composed of multiple materials that are generally considered non-porous and reflective to sound such as ceramic tile, plaster on lathe, and glass mirrors.

The overall sound levels and reverberation in the space were measured before and after sound absorbing baffles were installed. An average of the most common speaking frequency sound levels, called the speech interference level (SIL), was also measured before and after the treatment was implemented. Additionally, a survey was given to tasting room patrons to see if the customer experience was improved by adding a sound absorbing solution to the space.

If there is sufficient reverberation in a space, an echo is produced and the echo of the original sound can overlap subsequent sounds, resulting in conversation interference, music distortion, and other acoustical issues. Studies have shown a statistical relationship between noise reverberation and decreased intelligibility of conversation or instruction (Klatte et. al, 2010). Blending of reverberant sound waves can be desirable in certain venues such as orchestra halls or churches where choirs perform. In the case of smaller rooms, such as the tasting room in which we were investigating a solution, reverberant noise is viewed as an annoyance and as an obstruction to conversation (Rosenleif, 2015).

Beyond a simple annoyance, The State of American Dining in 2015 survey by Zagat showed that noise was consistently among the top two complaints of customers when rating satisfaction with restaurants (Zagat, 2015). Noise rated higher than the categories of unreasonable prices and crowds in this survey with 24% of the respondants listing noise as their largest complaint. Only ‘bad service’ was a ranked higher with 26% of those surveyed.

The ability of a surface material to absorb sound waves and thus reduce the reverberant noise in a room is a function of that material’s absorption coefficient. The absorption coefficient is the portion of total sound pressure absorbed by the material. Total absorption, denoted in sabins, is the absorption property of all room surfaces (Berger, 2003). Materials with high absorptive coefficients include thick carpeting, padded cushions, and specialty materials such as sound absorbing panels or baffles. Conversely, low absorptive materials include tile, glass, or concrete.

A common treatment for reverberant rooms is to add materials with high absorption coefficients. Ceilings, walls, and floors may be covered with absorptive materials in order to increase total absorption and thereby decrease reverberation. Baffles may also be hung from the ceiling, absorbing the sound waves in a similar fashion to sound panels hung on a wall.

After four years in the tasting room and distillation business, the owners at Headframe Spirits decided it was time to address the sound reverberation of the space and explore the feasibility of implementing engineering controls to minimize the reflection of sound waves.

Methods: Estimating and measuring room absorption, RT60, and Speech Interference Level

The reverberant properties of the tasting room were initially estimated and later measured. This was accomplished by two methods. Total absorption was estimated by calculating the surface area of the room and determining the absorption coefficient for each surface through established processes in accordance with academic and industry standards (Anna, 2011). Surfaces in the Headframe tasting room included tile flooring, carpeting on concrete, painted concrete, glass windows, and others. The absorption coefficients for the various surfaces of the tasting room ranged from 0.01 for mirrors and concrete to 0.65 for carpeting. The total absorption for the room was then plotted against the total volume of that space to estimate the reflective qualities.

The second method of characterizing room acoustics was through direct measurement of reverberation time (RT60) in the space. The RT60 is the time, in seconds, for a sound to decrease by 60 decibels. The higher the RT60, the more echoic the space. To measure RT60, a loud sound is generated and the time it takes for the sound to drop by 60 dB is measured. A “desirable” RT60 varies with the intended use for the space. Higher reverberation times tend to blend music and work best in choir halls and orchestral venues. On the other hand, lower reverberation times are best for conversation and are desirable for courtrooms or classrooms (Nave, 2005). It was decided that the tasting room space lies somewhere between these two extremes; it is used as both a conversation space and a music venue. Thus, the goal for the tasting room was to decrease the reverberation from a high RT60 value to a moderate RT60.

The RT60 was measured with a 3M Quest Sound Level Pro Meter equipped with RT60 measurement software. The RT60 was measured at hearing height in the center of the room using a pulse of sound created by bursting a full 10 inch diameter balloon with a thumb tack. Past studies have shown that some pulse sources, such as a starting pistol, create too narrow a frequency of sound whereas the balloon creates a broad frequency pulse (Norby, 2012).

In order to quantify the degree of speech intelligibility in the tasting room prior to and after the implementation of the room treatment solution, the SIL was also measured.

The SIL is a measure of how loud a noise is at three specific frequencies that are important to understanding speech (500, 1000, and 2000 Hz). An SIL over 75 indicates difficulty hearing at distances greater than four feet. Once the SIL is over 90, speech will be virtually impossible to understand regardless of distance between speaker and listener. Using the same Quest sound level meter, measurements at these frequencies were taken at the east end of the bar, mid bar, and on the west end of the bar on an evening when most of the tables were filled with patrons, but when no live music was playing.

In addition to the initial tasting room reverberation assessment, a voluntary survey was offered to the customers in order to gather data on the subjective noise experience of customers in the tasting room space. This short survey was offered to patrons by the tasting room staff and specifically asked, "How would you rate your satisfaction with the following noise level components in the tasting room? A. general noise levels; B. speech intelligibility; C. music listening quality." Each of these three items was assigned a rating from very dissatisfied (1) to very satisfied (5). The customers were allowed to comment on the sound quality of the tasting room as well. The survey was provided to patrons both before and after the installation of sound absorbing baffles.

All measurements, RT60, SIL, and customer survey; were repeated after sound absorbing baffles were installed in the tasting room. The measurements before and after installation were compared to verify the effectiveness of the sound baffles. Data were collected at the same points in the tasting room before and after the installation.

Results: Improvements in RT60, SIL, and Customer Experience

The results of the initial reverberation assessment are presented in Table 1 as "pre-treatment" values. The average total absorption in the tasting room was 46.2 sabins with a total room volume of 395.6 cubic meters. Prior to the installation of any reverberation reduction solution, the range of absorption was 26 sabins to 68 sabins depending on the frequency.

The pre-treatment calculated RT60 value was 1.62 seconds on average across 250-4000 Hz. The measured RT60 time before any action was taken had an average of 0.85 seconds across the same frequencies.

The average SIL was 80.4 dB on the west end of the bar, 80.2 dB mid bar, and 78.9 dB on the east end of the bar prior to the acoustic manipulation, for an average SIL of 79.8 dB. These levels indicated high difficulty in hearing normal conversation levels at greater than two feet between speaker and listener.

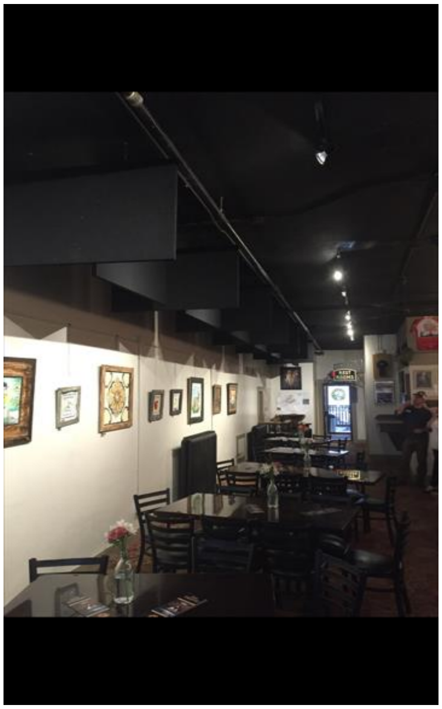
The customer survey was taken by 38 individuals prior to any acoustic manipulation in the tasting room space. The average values for the three categories of overall noise level satisfaction, satisfaction with intelligibility of speech, and satisfaction with music quality were roughly 'neutral' at 3.2-3.5 prior to room treatment. Some customers also left feedback. Many of the comments before a treatment was installed were negative, including, "There are very limited opportunities to enjoy a conversation," and, "Too much noise competing in the area."

To address the problems of high reverberation, speech interference, and customer complaints, sound absorbing baffles were installed in the tasting room. The baffles chosen for the tasting room space were designed to be mounted on the ceiling. Each baffle measured two feet tall by four feet wide and two inches thick. These were selected based on the absorption qualities, pleasing aesthetics, ease of installation, and to avoid interference with existing fire suppression system mounted on the ceiling. The specific baffles chosen were Audimute Soundproofing eco-C-tex baffles with a matte black finish.

Table 1. Calculated and Measured Tasting Room Reverberation Values Pre and Post Treatment with Sound Absorbing Baffles

	Total Absorption (sabins)	Calculated RT60 (seconds)	Measured RT60 (seconds)	Speech Interference Level
Pre Treatment	44.6	1.64	0.85	79.8 dB
Post Treatment	80.6	0.86	0.49	67.2 dB

The owners of Headframe Spirits purchased and hung 50 sound absorbing baffles from the ceiling in the tasting room. The baffles were hung vertically, perpendicular to the ceiling. The installed baffles only covered 37 square meters of ceiling, which was less than originally planned because of the need to provide adequate space around the room’s fire suppression system.



The baffles were installed in April, 2016 by Headframe Spirits staff. Post-installation assessments were performed the following weekend.

Using the same methodologies as the pre-treatment evaluation, a post assessment was conducted; those results are presented in Table 1. The very high noise reduction coefficients of the baffles, a rating of 0.4-1.0 across various frequencies, added 37 sabins of added absorption at higher frequencies to the tasting room. The total absorption in the tasting room was 1.74 times the initial absorption after the baffle installation.

The RT60 time calculated using the room size and total absorption prior to any absorptive baffles were installed was 1.64 seconds, which falls in the 1.5-2.0 range for music venues, but well outside of the ranges for ideal levels for a conversational space of 0 .4 seconds to 1.0 seconds (Nave, 2005).

The average measured pre-installation RT60 time was 0.85s. The measured RT60 time post-installation was 0.49 seconds. This substantial decrease was noticeable to staff and customers.

The SIL averages were lower in all three locations when measured after the sound absorbing baffles were installed. The average SIL decreased from 79.8 to 67.2. This substantial reduction brought the tasting room SIL down to levels considered acceptable for normal conversations. The reductions that were measured may have been a direct result of the room treatment, but may have also been coincidental since the ambient noise levels were not controlled and the measurements were taken during approximately similar evenings as opposed to being measured with a controlled sound source. For this reason, one should take the SIL reduction values with a "grain of salt."

Eighteen customers completed the same survey after the sound absorbing baffles were installed. The average rating for each item increased considerably, from 3.2-3.5 up to 4.2-4.5, indicated much improved customer satisfaction. Specific customer feedback also became more positive with comments including, "I could actually engage in conversation because I could hear the people around me" after the baffles were installed.

At the end of the project, we had to ask ourselves several questions: Were the acoustics improved? Was any improvement worth the money invested? Are the customers happy with how the baffles look and the sound levels and reverberation in the room?

The reverberation time was greatly reduced following the installation of sound absorbing baffles, which was a primary objective of our project. Additionally, speech interference was reduced and customer satisfaction increased. The cost was just above $3200 for the baffles and onsite labor was used for the installation. So, one would have to weigh the benefits versus cost for other spaces, but in our case the baffles were well worth the investment. It is fair to say that the customers are appreciating the new tasting room improvements and many have even commented positively on the appearance of the baffles. All involved parties are pleased with the installation and this treatment ended up serving both purposes of improving the acoustics in our tasting room while also increasing the aesthetic appeal of the space.

Headframe Spirits was established in 2012. More information on our distillery can be found at www.**headframespirits**.com

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