Budgets vs. Acoustics – Play Like a Team and Win

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Attaining noise and vibration goals for a new or retrofitted school performance space can be an exercise in futility due to publicly funded budget constraints and a tendency to seek acoustics advice after design development. This can add cost and delay later in design, when control treatments must be added after the fact. Limited funding notwithstanding, there is a path toward acoustics success in such situations. This article will explain how early involvement allows an acoustics engineer to collaborate with the entire team to arrive at a cost-effective design that supports good noise and vibration control. To illustrate, we will share a case study where the architect involved the acoustics engineer in the initial stages of design of a school performance hall. After explaining how design team members' individual thinking led to a "prisoner's dilemma" that increased the cost of meeting acoustics requirements, I will share my proposed integrated design solutions that incorporated cost-effective noise and vibration treatments. My goal is to to impart an understanding of how to capitalize on early project involvement as well as how integrated, collaborative design by all team members can reduce conflict and cost and ultimately win the "game" for everyone.

Consulting enginering is not a one-size-fits-all affair. Every new project brings new challenges and expectations that, even in the best of cases, end up both exhausting and rewarding. Noise and vibration control consultants most often find themselves brought in either when a problem has become glaring during construction or when a concern outside another professional's scope of expertise is raised prior to construction. Efforts have been made within the industry to prove the value of a noise control consultant during the first stages of a new project. However, we often see specialized consultants are still not being brought on until many conditions have already been decided; they are then expected to work within these constraints rather than alter them to suit their discipline's needs. Such cases frequently end up as a "prisoners' dilemma," where each design team member decides the approach most beneficial for their individual system design – disregarding the input from other design teams and waiting to resolve design conflicts until after the design completion.

This article examines the benefits of entering a project during its initial planning stages versus entering once a "complete" design has already been drafted. It also looks at how a willingness to collaborate and compromise with other design teams during the drafting process can affect final design performance and cost.

The case study to be presented here is Pardeeville Middle School's new performing arts center and administration expansion. In 2016 IMEG was brought on as an acoustic consultant to aid in a probable-cost opinion for this new construction project. Working in these initial planning stages gave us a valuable opportunity to work on a new design without the necessity of conforming to previously decided conditions and allowed us to offer valuable design feedback before major decisions were made. The insights gained from that project based on conversations during the design process as well as feedback taken after the cost opinion was completed will also be discussed.

The Prisoners' Dilemma and Consulting

In game theory, there is a situation known as the "prisoners' dilemma." In this situation, two partners in crime have been arrested and offered a deal by the authorities. If they confess to their crimes and implicate their partner, they will go free. However, their partner will receive 10 years in prison. If both prisoners confess, they will each receive 8 years in prison. If they both maintain their lie and loyalty, they will each receive 1 year each. The latter option is considered ideal for both criminals; however, human nature is to not trust others. So more often than not, in theory, at least one prisoner will confess in a gamble for his or her own freedom.

		Design Team Member 1	
Design Team Member 2		Cooperate	Disregard
	Cooperate	Many goals met	Some goals met
	Disregard	Some goals met	Many goals met

Figure 1. Potential outcomes for project goals using "prisoners' dilemma."

This situation can be directly applied to the world of consulting. In consulting, two design members are tasked with meeting project goals based on standards, laws, and client desires. They can either cooperate with one another or disregard the considerations of one member to instill his own desires.

Potential outcomes in this situation are shown in Figure 1. The chart shows that while it is tempting to disregard the considerations and goals of other team members to pursue the "best" acoustics, the project as a whole will suffer because the goals of other areas have not been met. However, one must keep in mind that allowing all your goals to be completely diminished to meet another's will also cause the project to suffer. So one must endeavor to compromise with each design team when necessary and persuade them to consider your own goals into the design. This way, the majority of everyone's goals can be met, and the overall project succeed.

Background and Architectural Model

Pardeeville Middle School in Pardeeville, WI, proposed a new construction project to add an expansion to the school that would include an administration center and a performing arts cluster consisting of an auditorium, a band/vocal rehearsal room, and a set of private practice rooms. The architect hired to design the new wing was unfamiliar with designing performance spaces, so IMEG was contracted to advise on the initial designs as well as provide an opinion on probable cost that would be used to draft a referendum for taxpayer approval.

Administrators from the school insisted that they were seeking a performance space that would prioritize performance over cost, since the space would be used by both student and community performers. A budget of $6.5 million was set for the entire addition, and IMEG was given complete freedom to choose interior acoustic finishes.

Initial Architectural Model. The architect submitted preliminary drawings of the space. Only a basic floor plan had been proposed, and input on partition design and interior finishes was sought from IMEG. As the performance spaces were the priority for noise control, our focus was on the auditorium, band/vocal rehearsal room, and private practice rooms. Figure 2 shows the initial layout of these spaces.

Based on a paper presented at Noise-Con 2017, the 2017 Conference on Noise Control Engineering, Grand Rapids, MI, June 2017.

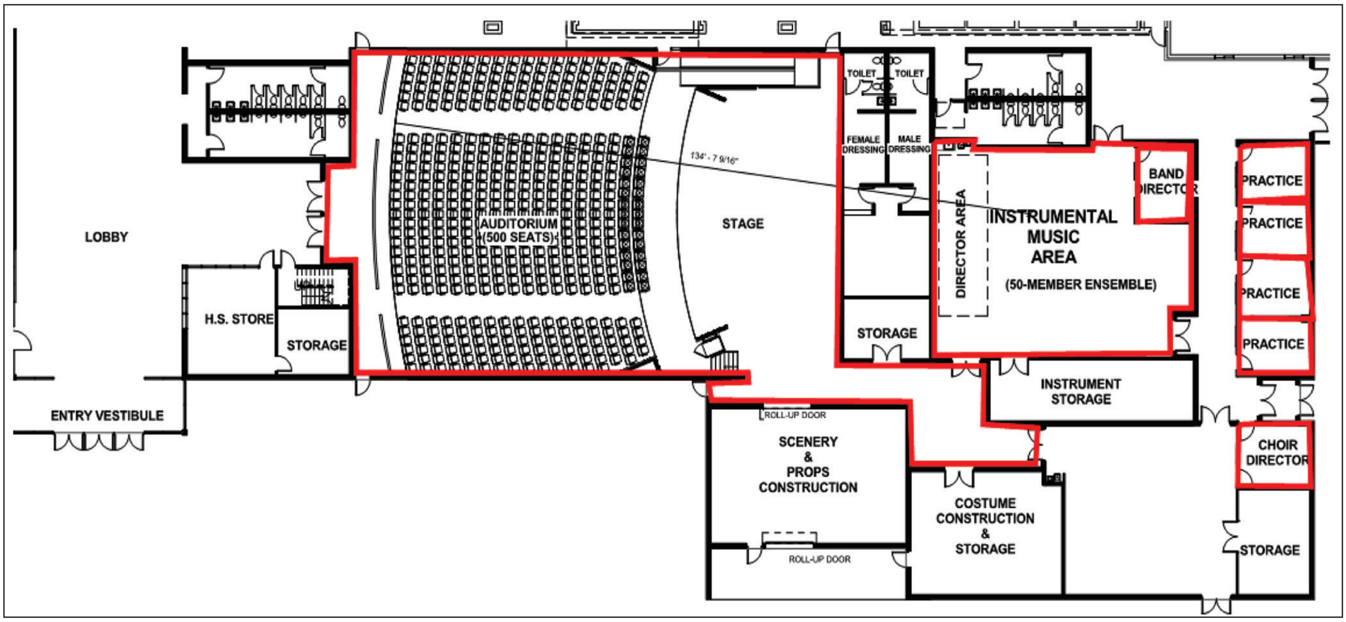

Figure 2. Initial design for performing arts addition.

Upon review of the initial architectural design, our primary concern was the proximity of these spaces to one another – especially since the school had expressed a desire for the ability to use all the spaces at the same time. The architect had placed the spaces close to each other for convenience's sake without realizing the disservice he was doing to himself, since this requires more work on his part to make the spaces simultaneously usable.

We pointed out that high STC partitions would be needed to isolate these spaces from one another. This would be a lot of added cost, but fortunately they were willing to accept this stipulation to keep their layout as designed. This is a perfect example of how collaboration and compromise improved the design. We relented to letting the noisy spaces be near one another, and the architect allotted for more cost and an altered partition design to make the spaces usable. For room finishes, we determined a need for significant absorption within the band room and practice rooms for these spaces to be considered functional. The auditorium would be designed for music and speech performance.

Noise Control Design Recommendations

Recommendations for the auditorium and band room were created based on a reverberation-time curve model. Recommendations for the private practice rooms were based on a study done by IMEG's Richard Vedvik in which a physical one-fifth scale model of a practice room was built and tested to overcome the small space limitations presented when modeling with the Sabine equation.

Auditorium. The auditorium was designed for use as a music and speech performance space. The prisoner's dilemma came into play here in regard to the noise consultant and the general contractor. The wall height was originally chosen as 39 feet. However, the general contractor wanted to reduce the height to 30 feet to lower material costs. They did not think about how this would affect the mechanical, electrical, and architectural design teams, since there would be less room for duct runs, light fixtures, and a proscenium.

Decreasing the overall volume of the space would affect the noise consultant, since it would alter the reverberation time as designed. Additionally, there would be much less room for an acoustic cloud system, which will perform better with the ability to vary the heights of the cloud panels. Additionally, we had originally chosen wood absorber/diffusion panels, but the general contractor did not want to accept the added cost and go with fabric panels, which would change the overall aesthetics of the space.

The following acoustic finishes were chosen:

- 2-inch acoustic-tuned absorber/diffusion panels
- Acoustic cloud system
- Tectum roof system
- 6-mm pile carpet
- Upholstered seating

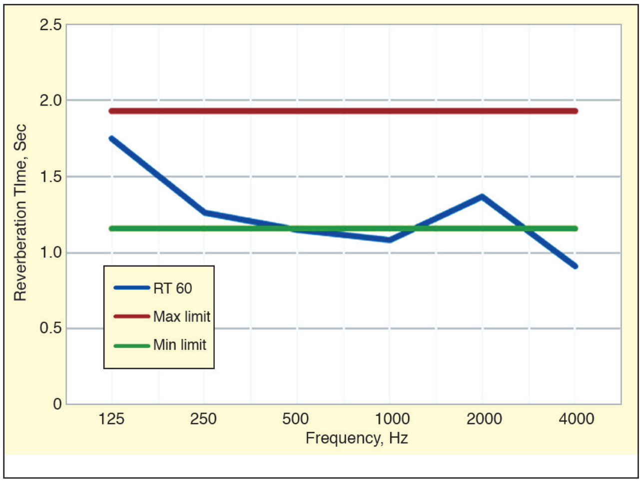

Figure 3. Auditorium reverberation curve.

Figure 3 shows the reverberation curve generated with these treatments. The goal limits were determined based on room volume and its status as a music and speech performance space.

We also worked with the mechanical engineer to outline the basics of a successful AHU system for the auditorium. To prevent noise transfer into the space, we persuaded them to place the unit over the lobby and duct into the space. We also convinced them to run the auditorium on a separate system from the band room and practice rooms to prevent crosstalk.

Finally, we decided on a return system that runs underneath the audience seating. By increasing the duct run distance we could reduce the amount of fan noise in the space. Had the mechanical engineer chose to disregard our advice, they could have created a less costly and more efficient system, but the noise produced would have been a large detriment to the final project.

Band Room. Originally, the architect had designed the band room as simply a regular classroom without accounting for the louder noise level within the space. Music practiced in this space would be less intelligible without added absorption, and its proximity to the auditorium would cause a lot of conflict between the two spaces. However, we felt that designing with a low reverberation time for only intelligibility would lead to a feeling of isolation for the performers, and the transition to performing in the auditorium would be jarring.

Again, the mechanical team could have done a disservice to the noise consultant by running the whole performing arts wing

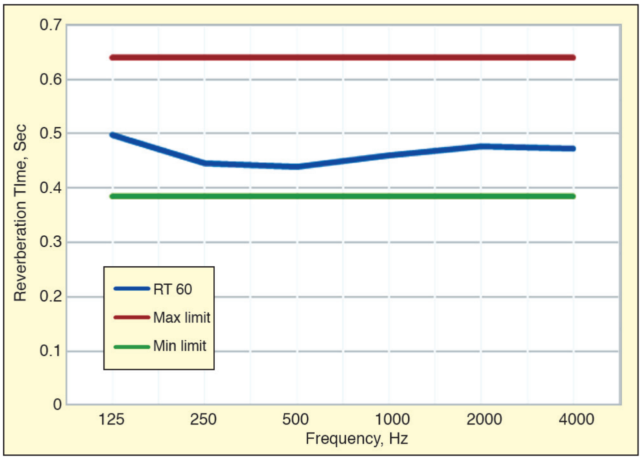

Figure 4. Band room reverberation curve.

with one unit. Instead, they took noise into account and specified a separate unit for the band and practice rooms.

To achieve an intelligible music learning space, 3-inch acoustical absorber panels were used. Figure 4 shows the reverberation curve generated with this treatment. The goal limits were determined based on room volume, room functions as both a music and learning space, and ANSI12.60 guidelines for classrooms.

Private Practice Rooms. A set of four private practice rooms was to be built in the addition. Due to the small volume of these rooms, absorption is heavily used to overcome the room modes and increase intelligible feedback for the individual playing. To lessen the modal effects and decrease cost, the architect could have designed only two practice rooms with a larger volume. This would have made the jobs of both the noise consultant and architect easier. However, the increased number of practice rooms allows for more students to take advantage of them.

The following acoustic finishes were recommended:
- 1-inch acoustic tuned absorber/diffusion panels
- Wood diffuser panel
- Mirror
- Acoustic cloud created with a grid of absorber and diffuser panels

We also had to work with the mechanical engineer to set goals for these spaces. The smaller room volume meant that fan noise from the HVAC system would seem louder, since the source is closer to the room occupants. This meant they had to aim for a lower NC than originally planned and utilize noise remediation such as silencers or duct lining that they may not have originally accounted for.

Client Insights

Upon completion of the opinion on probable cost, IMEG conducted a candid exit interview with the superintendent of the Pardeeville school district to gain insight about our abilities to communicate effectively and meet the clients' expectations for our services. From this interview, we gained valuable insight to apply to future projects and client communications.

Coordination is Key. Design teams can only be successful if each member can control his ego. Design criticisms should not be borne out of spite, and it is important to be diplomatic about any changes one wishes to make to another's work. Noise control consultants must be flexible in working with every design discipline involved and not come off as overbearing to the entire project. Each discipline should not be designed in a vacuum, so coordination at the beginning and during design is crucial to establish a shared approach toward a shared goal.

A positive attitude is extremely important to maintaining a coordinated effort. Compromise will be key at some points; however, we should avoid compromise for the sake of avoiding conflict. Be honest with the client and design team even when your opinion is at odds with theirs. Conflict is not inherently detrimental to a project, but our approach to conflict should not be without civility and a willingness to reach resolution.

If nothing else, any good salesman knows it is much easier to sell someone on your ideas if they believe they were theirs first. Clients will be more accepting of design decisions if you highlight the future positives – such as how much performance will be improved – instead of highlighting present negatives, i.e., how bad their current design is (except as a direct comparison to the improved design). Finally, it does no good to fret over noise control recommendations that are not accepted in the final design. Instead, recognize that even if only a fraction of your recommendations is accepted, the project will be better than if you had not been involved at all.

In the Pardeeville project, we were able to convince the other design teams to integrate most of our advice into their early designs. However, there was an issue with the sound booth design in the auditorium. We advised placing the booth on the main floor of the auditorium so that live sound workers could get live feedback from the room. The school wanted to place a booth on the second floor in a separate room due to security concerns for the equipment. While we suspect this could cause workers to overshoot performance levels, all we could do is advise against it and graciously accept that it is their space to do with as they please. Becoming combative over this design aspect could turn them against our other recommendations and put us in a negative spot with the client and overall project.

Using Bad Acoustics. Nearly any auditorium will perform better acoustically as a performance space than a gymnasium. In the Pardeeville project, the school's music groups were using the gymnasium for all their concerts. As expected, there were many problems with noise level and intelligibility. However, it was this experience with "bad" acoustics that led to their willingness to accept our design decisions. We should keep in mind it will be harder to sell acoustics for existing spaces' upgrades/retrofits even if they are underperforming acoustically, since these clients won't be as experienced with truly bad acoustics – and may view it as us fixing something that isn't broken. As such, a different approach to marketing and design is needed for new and existing construction.

Prove Your Value. Clients with little to no experience dealing with noise control will usually be reluctant to accept recommendations they see as costly. The easiest way to sell noise control is to demonstrate how spending money for the initial construction is preferable to spending a greater amount later if the space was not designed with these concerns in mind. As a general rule, postconstruction remediation will cost twice as much and be half as effective compared to preconstruction design integration. Educating clients and disciplines outside our industry is a must to prevent designing for "good enough" over "good acoustically." We must promote our value as consultants early on so that in the future, others will be more open to our solutions and our involvement requested before noise problems get built into the design.

Conclusions

Noise and vibration consultants must resist the urge to take the path of least resistance in the design process. Acoustic recommendations cannot be drafted while ignoring input from all design disciplines involved and then left for a client with a take-it-or-leave-it attitude. Collaboration needs to occur with every team at every design step to ensure the project can meet the end user's expectations for both performance and cost. Consultants also should be proactive in entering every project as early as possible to prove their value not just for a niche portion of the project but as a multidisciplinary resource for the benefit of the design team at every step of the design process.

Acknowledgement

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Reference

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