VALUE ENGINEERING 'ACOUSTICS' INTO PROJECTS

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1 Introduction

It can be said that 'cost' is the most significant constraint in the construction or remediation of buildings. More specifically, a project's budget is regularly overrun by its expenses—negatively impacting its [the project] health, as well as its various stakeholders (e.g., building professionals, engineering specialties, trades, and subcontractors). This is often the case in remediation efforts, where seemingly simple acoustical solutions, such as barriers and silencers, require complex engineering.

The 'hidden' costs associated with these critical multi-disciplinary engineering challenges are not usually apparent during the initial estimating stage and can exceed the estimates for the acoustical scope. This unknown cost risk is further amplified in large scale complex retrofit noise mitigation projects where the abatement plan may cover multiple years and involve dozens of sources. However, the determination of these unknown costs can be uncovered quickly and efficiently during an initial feasibility design study. By uncovering these costs sooner, projects can be completed more efficiently allowing plant management to properly plan and allocate capital financing more accurately for the project.

This paper characterizes types of projects where there is an intrinsic benefit to conducting an initial design feasibility study to determine the required scope of work prior to the commencement of a project. In these examples, the implications of unknown or unforeseen costs are detailed, demonstrating the financial risks.

2 Initial Design Study and Project Benefits

An initial engineering design study is intended to confirm solution feasibility while dramatically reducing unknown cost risk (i.e. within 25% of construction) associated with complicated large-scale projects.

Three types of projects that benefit most from such a study are described and detailed within this paper. These include:

- Retrofit involving multi-discipline engineering and sub-trades,
- Facility-wide noise mitigation with unknown site-specific challenges,
- Noise abatement projects exceeding 'normal' scale.

2.1 Retrofits involving multi-disciplinary parties

As the number of independent parties involved in a job increases (i.e., consultants, engineering specialties, trades, and sub-contractors) so too does the complexity and unknown cost risk associated with the job. The earlier the coordination and communication between these separate parties can occur, the earlier any unforeseen expenses can be captured, and a more accurate estimation can be provided.

The modelled enclosure detailed in Figure 1 presents a project where an initial noncompliance with provincial sound level limits resulted in a complex engineering design study involving various multi-disciplinary engineers and trades. This project consists of newly proposed residential development overlooking the mechanical rooftop equipment of a grocery store and restaurant. Due to the proximity of the windows of this new development to this equipment, the noise abatement option was to acoustically enclose and replace the entirety of the mechanical equipment on the roof.

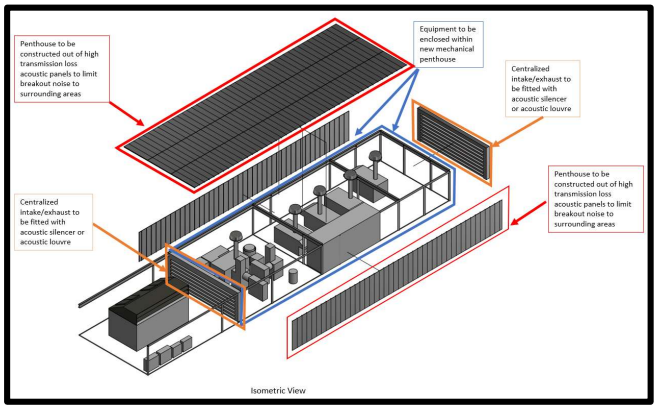

Figure 1: Mechanical Penthouse Enclosure intended to reduce noise emissions to adjacent residential development.

To reduce the risk of interruptions to impacted persons, a detailed investigation of the required cooling capacities of each of the tenants was conducted for proper selection of equipment and phasing of the noise abatement install. Mechanical design consisted of reselection of mechanical equipment, determination of proper air ventilation and cooling capabilities to each of the tenants.

This work was conducted concurrently with a structural assessment of the base building, and acoustic modelling of sound levels from the new equipment on the adjacent development. The acoustic modelling at each of the noise sensitive receptors fed into both the mechanical selection and any additional noise abatement required at the outlets of the enclosure.

2.2 Facility-wide noise mitigation with unknown site-specific challenges

Site-specific constraints or limitations that are unknown at the initial estimating phase of a project can result in a significant increase in cost and delays during project implementation. The extent of these costs and delays become significant

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in multi-year facility-wide noise abatement projects that often include many sources of noise. Uncovering these limitations on the onset allows plant management to effectively plan and secure capital financing prior and during the project lifecycle.

An example of a large facility-wide noise abatement project is shown in Figure 2. This project consisted of an older industrial facility requiring noise mitigation on dozens of exhaust fans located on its various roofs. Due to the elevation of these fans, additional dead load was required to counteract the high wind loads imposed on the new silencers. As a part of the initial feasibility study of the project a structural review determined that the existing roofing structure required a significant amount of structural reinforcement prior to the installation of any noise abatement on the exhaust fans on each of the facility's five roofs).

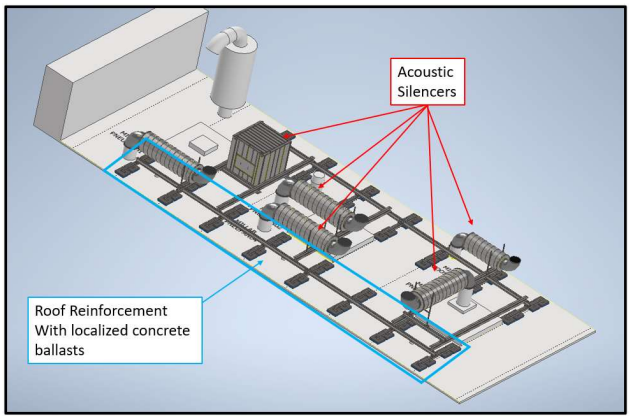

Figure 2: CAD model detailing extent of structural reinforcement with acoustical mitigation for facility-wide mitigation project.

Figure 2 illustrates the complexity of the structural framing and distribution of weight of noise control solutions. The feasibility study ensured the financial wellbeing of the client, and, therefore, the project. It also reduced the time required for design and avoided delays to the project. The feasibility study empowered the client with the information necessary to better plan, budget and manage their project.

2.3 Noise abatement projects exceeding 'normal' scale

The benefits of a preliminary engineering study become more evident as projects grow (in size) and complexity. Atypical engineering needs, constraints and/or limitations are threats to the completion of the project. A detailed engineering review by an experienced and specialized team can reduce the number and extent of uncertainties to allow for better planning of costs, milestones and deadlines. Figure 3 is a photograph taken during the install an acoustic barrier that is 10 m in height and 90 m in length. The intent of the acoustic barrier was to shield facility trucking noise from an adjacent condominium.

More specifically, a detailed engineering design study was conducted to establish costs and timelines for the proposed acoustic barrier solution. Because of the significant height of the barrier, as well as other onsite conditions, it was determined that the foundations for the posts needed to be significantly deeper than typical recommendations; thereby impacting their cost. This also affected the design and cost of the barrier. More specifically, the lengths of the structural steel columns needed to be longer—to coincide with the deeper foundations. Additional optimizations were required to properly overlay over any deflections.

Figure 3: Photograph taken during the install of a large 10 m acoustic barrier.

In addition to cost, a design study allowed a more accurate prediction of project timelines. Detailed breakdowns of lead times were critical for scheduling of permitting (with the local municipality) as well as installation of the foundation to occur prior to the winter months. Careful coordination with the client, acoustical consultant, and various contractors were needed to properly layout the barrier in relation to existing site conditions while ensuring the acoustic performance of the barrier was accurate to what included in the acoustic consultant's model.

3 Conclusion

Through the implementation of an initial feasibility design study, 'hidden' costs and unknown site-specific challenges can be uncovered in a timely manner for large scale noise abatement projects. In some projects, these costs can be of comparable scale to the actual supply of the noise abatement product. By uncovering these costs sooner, projects can be completed in a more efficient manner allowing plant management to properly plan and allocate capital financing more accurately.