



Lessons in Education Building Design

David Borgeaud (1)

(1) Acoustics Noise Vibration Consulting Engineers, Brisbane, Australia

Abstract - Education projects come in many shapes and sizes – from learning centres with general learning areas, to performing arts complexes with music, dance and drama studios, to indoor and outdoor sports facilities, kitchens and industrial technology and design buildings with full engineering workshops. Limited available land often requires use of multi-level, mixed use buildings, and location of facilities closer to residences. The level of acoustic input varies for each project and may include not just the room acoustics but also noise radiating to residential areas. This paper discusses the author's experience with several education projects.

1 INTRODUCTION

Modern education buildings need to provide high quality facilities for students and staff to meet the changing careers market for both Australian and overseas employment. Facilities may include: learning centres with indoor and outdoor learning spaces, visual art and multi-media spaces, performing arts complexes with music, dance and drama studios, large halls for indoor sports, commercial type kitchens, and industrial technology and design buildings with full engineering workshops. Many educational facilities have limited land on which to operate. This results in more “vertical education” campuses, where multi-story buildings are used. It is common for these buildings to have mixed uses including noisy spaces amidst learning spaces. Many of these facilities require significant acoustic input to achieve the desired outcomes for the spaces. After completion of projects, it is important to seek feedback from the staff who use the facilities to continue to improve the design for future facilities. This paper provides some of the information gathered from various projects visited after completion.

2 MASTER PLANNING

Acoustic input should be provided during the master planning stage for educational facilities not only to address noise impacts caused by conflicting uses in the buildings and on the site, but also to reduce external noise intrusion and control noise radiating from educational facilities to nearby noise sensitive uses. External noise impacts on the site may include transport, industry and other external noise sources. These impacts can usually be readily controlled for air conditioned buildings with suitable façade acoustic design but for naturally ventilated buildings noise control is limited. Naturally ventilated buildings may include: sports halls, art studios, workshops, kitchens, and outdoor learning areas. Outdoor sport areas may also be impacted. Fortunately most of these facilities are typically noisy when in use which may reduce the significance of noise intrusion, however external noise intrusion should be controlled where practical to enable suitable communication between staff and students and for periods when the space is used for quieter activities - for example when a sports hall is used for exams, assembly, speech night or community uses such as church services or training.

Noise radiating from the educational facilities to nearby residences or other sensitive uses can be generated by: sports inside halls, workshops, outdoor sports courts, outdoor play areas, air conditioning plant, and workshop fume and dust extraction plant. As noted above, sports halls and workshops are typically naturally ventilated and hence the façade cannot be closed to reduce noise emissions. In some cases workshops have been air conditioned, however this has potential health, safety and maintenance issues. For example, welding booths need to be well ventilated to minimise fumes, and the dust generated in timber workshops can impact the performance of air conditioning fan coil units by choking the return air filters.

Considering the above constraints and opportunities, it is preferable to locate air conditioned buildings near noise sensitive uses or where external noise levels are highest, so that the façade can be closed and acoustically designed to control noise intrusion and emission. Naturally ventilated buildings should be located away for noise sensitive uses and where practical located away from external noise sources. Outdoor sport courts and playgrounds should be located away from sensitive uses. Sports fields and ovals can be used to provide a good buffer distance between educational facilities and off-site noise sensitive uses.

3 SPORTS HALLS

These buildings are usually a large structure as they require clearance heights for ball sports, gymnastics such as use of trampolines, badminton and other sports. Figure 1 shows a large indoor sports hall. Due to the large volume of these spaces, they require significant areas of acoustic absorption to control reverberant noise. Suitable reverberation times can be derived from Australian Standards and education guidelines. The reverberation time criteria should be used as a guideline and it considered good practice to generally minimise reverberation times to enable staff and coaches to communicate with students and team members. Sports halls are often used for assembly of staff and students and suitable sound systems are usually installed for this purpose. Provision of some reflective and diffusing elements on the walls can assist in providing useful lateral reflections for music presentations in the space.

Owners of educational assets typically encourage the use of facilities by the community. Many sports halls are used by the community on weekends and evenings for a range of activities including: basketball, volleyball, martial arts, dance classes, and church services. It has generally been found that residents have a reasonable tolerance for the extended use of such facilities, however it should be noted that these non-educational uses are not covered by the same exemptions from noise criteria that the educational uses enjoy. As a result, the educational institutions may require noise management plans to control the use of the facilities by groups that may cause complaints. For example, the use of a hall early on Saturday mornings for Zumba classes which included louder music with a strong bass beat caused complains for one educational institution and this use had to cease.

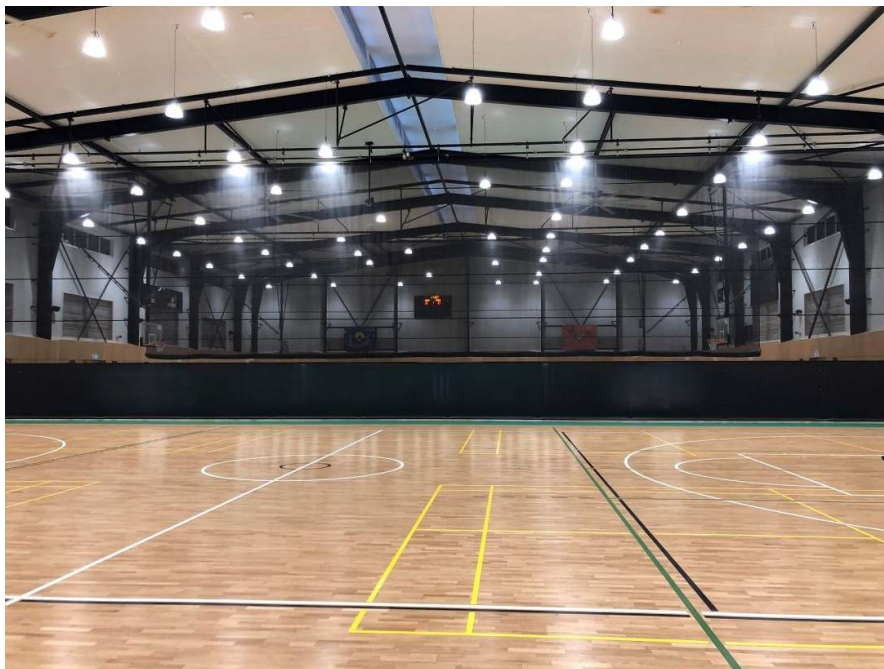


Figure 1 – Large sports hall with three indoor courts and sprung timber floor

3.1 Learning spaces under Sports Courts

Sports halls are usually built with a concrete floor slab or with a floor on joists with an unoccupied undercroft. This avoids the issue of footfall and impact noise to occupants in the space below the floor. However the lack of space on educational sites can result in the desire to locate occupied spaces under sports halls. One hall was designed with learning spaces and a staffroom under the sports hall. To minimise footfall and impact noise and vibration intrusion, the learning spaces were designed with a double ceiling and double stud walls. The frame of the learning spaces was designed to have no contact with the floor structure or supporting columns of the sports hall. Figure 2 shows the general arrangement of the design. The steel beams for operable walls between learning spaces were supported on steel posts from the ground floor slab – no contact with the concrete columns or concrete floor of the sports hall. Feedback from the users was that while low frequency noise from the hall was audible at times, the staff had no issue with the acoustics of the learning spaces or staffroom. While this indicates that learning and other occupied spaces can be built under sports halls, it is recommended that this be avoided where practical.

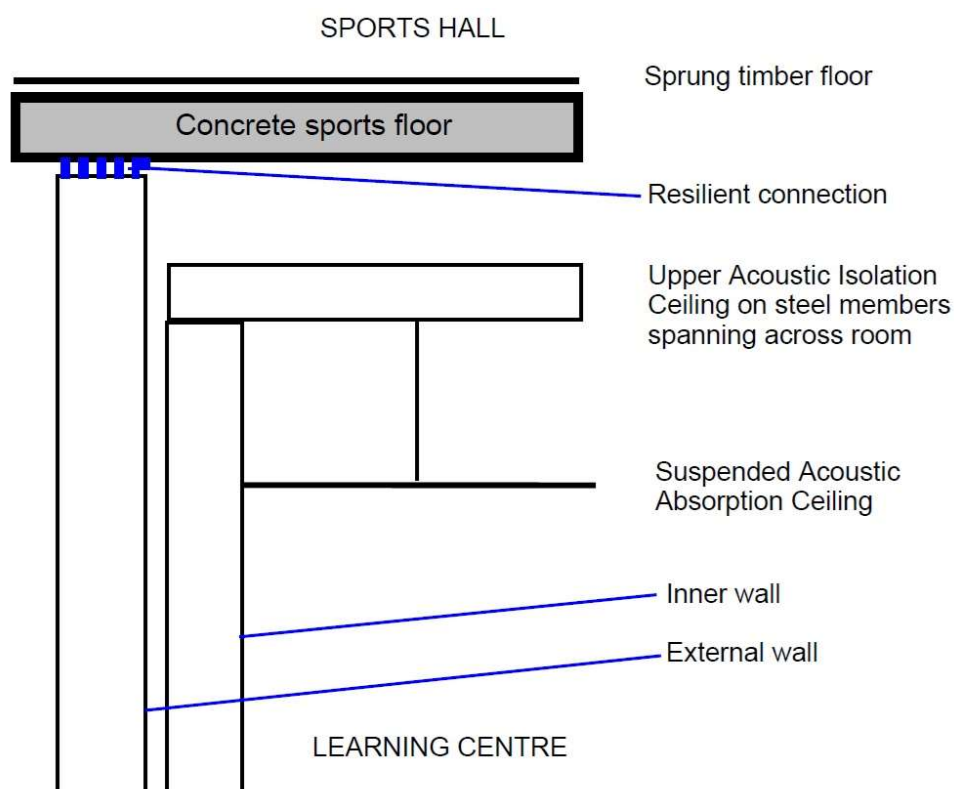


Figure 2 – Typical section through isolated ceiling and walls under sports hall floor

3.2 Natural Light

An existing covered sports area was converted into an enclosed sports hall to provide an all weather facility. Acoustic treatments were provided to reduce reverberation in the space, and acoustic louvres were provided along one side of the space to reduce sport and dance class noise to a nearby multi-level learning centre. Feedback from the users was that the acoustics were good, but the architectural design relied too much on electric light and did not provide enough natural light. This made it more difficult play volleyball or badminton as the players tend to lose sight of the ball or shuttlecock when it is high.

4 PERFORMING ARTS – MUSIC, DANCE, DRAMA, MULTI-MEDIA

Performing arts buildings often include a central performance space which can be divided using operable walls to create 3 - 4 studios as shown in Figure 3. These studios can be used for separate groups learning dance, drama or music as shown in Figure 4. Music practice rooms, recording studios and multi-media rooms are provided in some performing arts buildings.

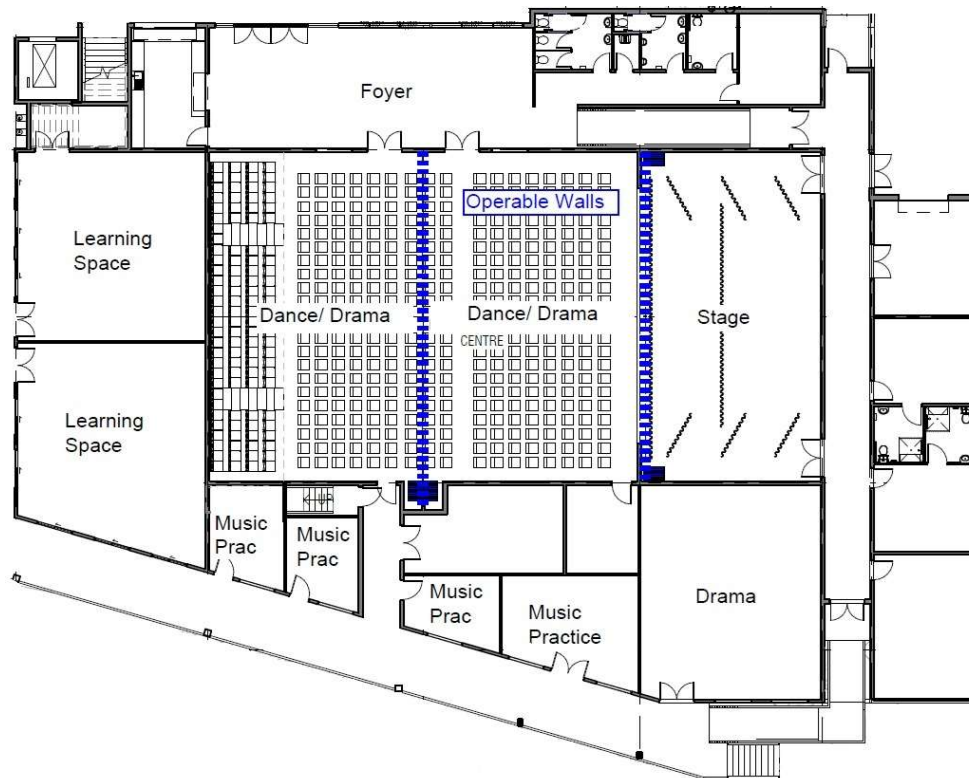


Figure 3 – Performing Arts Centre floor plan showing operable walls and music rooms

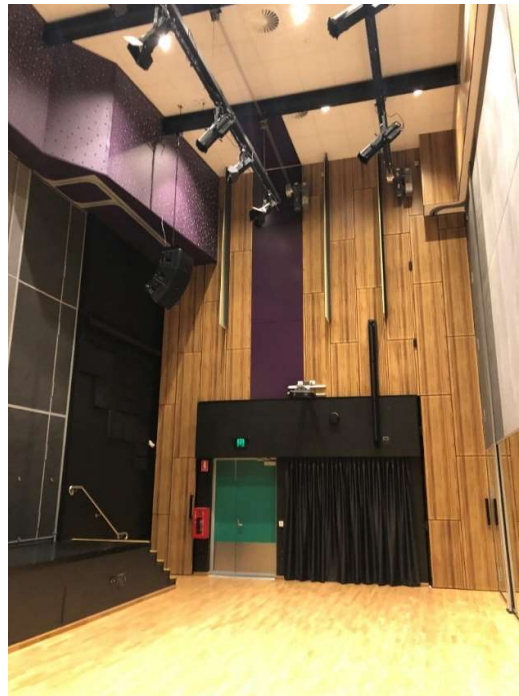


Figure 4 – Dance studio created by closing the stage and adjacent dance operable walls

4.1 Operable walls

While operable walls provide flexibility for the performing arts building, feedback from some users has been that the effort and time taken to extend and retract the panels is impractical if the space is used for larger groups on a regular basis. In this case the educational institution said they would prefer a separate hall or auditorium that could be used for these larger gatherings. The auditorium in the performing arts would then only be used for music, dance or drama performances on special occasions.

The “as built” acoustic performance of operable walls is often reduced by flanking noise travelling either over the top of the wall via the supporting beam bulkhead or via the wall cavity. It is important that the builder understands the reason for acoustic treatment of flanking paths. One builder assumed that butting the operable wall into perforated wall sheeting would be suitable, as the perforated wall sheeting was “acoustic”.

4.2 Music

Music practice rooms require a high level of acoustic isolation to enable students to play different songs in adjacent rooms. Figure 5 shows a large music practice space on the stage of a performing arts centre. It is preferable for these rooms not to use operable walls, as fixed walls can provide more reliable acoustic isolation. Acoustic absorption is required for music practice rooms to control noise levels in the space and minimise potential hearing loss issues for staff and students. Feedback from staff in older music rooms with minimal acoustic absorption is that they are too loud. Variable acoustics can be considered for some music rooms. This usually involves the use of acoustic panels or curtains that can be moved to make the room more live or more dead to suit the type of instruments and music. However observations in several music facilities indicate that the treatments tend to be left in one place, or in some cases the panels have been removed from the practice rooms. Feedback from music staff is that they don’t have time to move acoustic panels around before or during lessons. So the use of fixed acoustic absorption appears to be the more practical approach. One of the main items raised by music staff is not acoustics but the lack of storage space for instruments.

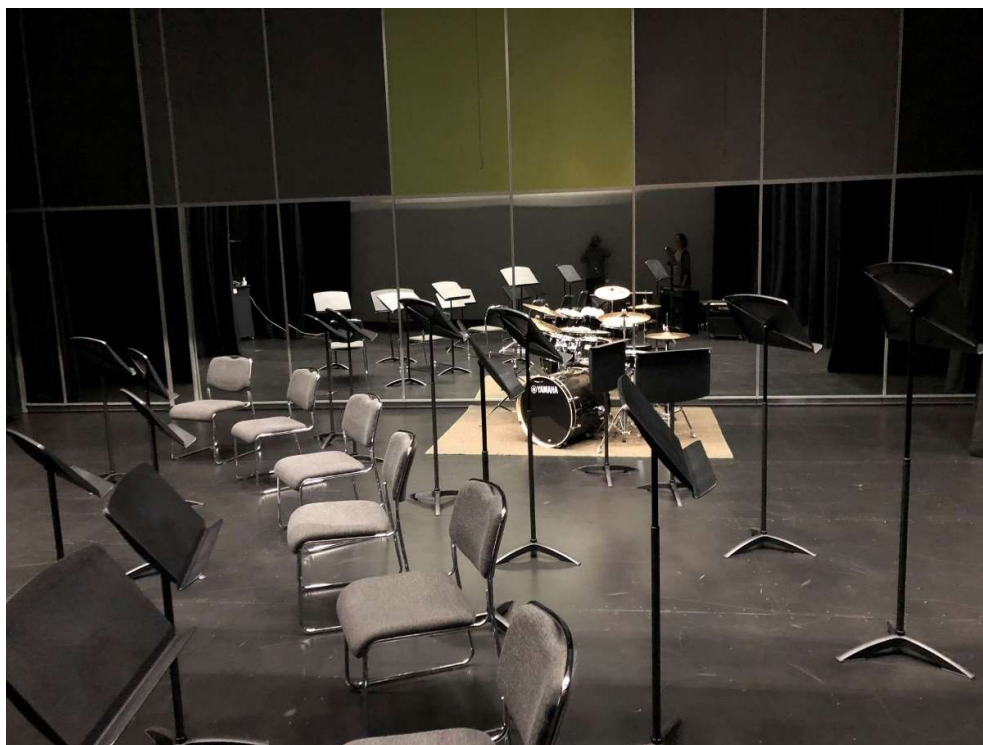


Figure 5 – Large music practice space

4.3 Dance

Dance studios are usually provided with sprung timber floors to reduce the chance of the injury to dancers. Where operable walls are used to divide dance studios, the sprung timber floor runs under the operable wall between the rooms. This can result in footfall noise from one dance studio being clearly audible in the adjacent studio. An isolation break should be provided in the sprung timber floor along the line of the operable walls to reduce footfall noise between studios.

5 INDUSTRIAL TECHNOLOGY AND DESIGN

Modern facilities include full engineering workshops with welding booths, compound mitre saws, routers, planners, lathes, milling machines, nail guns, spray booths and other equipment. Figure 6 shows a new senior engineering workshop with welding booths and fume extraction system. Mechanical plant associated with these facilities includes: supply and exhaust air fans, air compressor, fume extraction systems and dust extraction systems.



Figure 6 – Senior engineering workshop with welding booths and fume extraction system

5.1 Noise inside spaces

Acoustic isolation is required between the workshop spaces, staffroom and design spaces. Where practical the design spaces and staffroom should be located away from the workshops. At a facility where only a basic level of acoustic isolation had been provided, the staff said they no longer use the room for teaching due to workshop noise and endeavoured to use other rooms more removed from the workshop noise for teaching.

Workshops often require higher ceilings for equipment, and this larger volume can become quite reverberant with the required hard floor finishes. To control reverberant noise acoustic absorption treatments should be provided to the ceiling and to sections of the walls. Where practical, noisy equipment should be located away from quieter activities.

5.2 Noise to sensitive receptors

Workshops should be located away from residential and other noise sensitive uses where practical to minimise noise impacts. Workshops are generally naturally ventilated as discussed in Section 2, as use of air conditioning has potential health, safety and maintenance issues.

In addition to workshop noise, the mechanical plant associated with the workshops can create relatively high noise levels and must be located and acoustically treated to meet the required residential noise criteria. Treatments for dust extraction plant often requires a separate plantroom with concrete block walls, acoustic linings to the walls, and an acoustic attenuator or acoustic louvre on the air discharge.

Observations on several sites indicates that most residents appear to be quite accepting of educational facility workshop noise, particularly if the facility has been in place for some time. Feedback from staff has indicated that complaints have been rare, apart from when there is an unusual noise. For example one facility received complaints when the air compressor had been left on overnight and the compressor would occasionally run to maintain the pressure in the system. It is recommended that the workshop mechanical plant in particular be designed to meet the relevant noise criteria to protect nearby residential or other noise sensitive uses.

6 FINAL REMARKS

It is expected that education facilities will continue to be built and developed with land constraints. This will require ongoing acoustic design input preferably at all stages of projects from master planning through design stages and construction inspections to deliver suitable outcomes. It is recommended that feedback from the users of facilities be sought to provide continued improvement in the acoustic design.

ACKNOWLEDGEMENTS

The author would like to thank the users for their time to allow facilities to be inspected and for their feedback.