OVERCOMING EXISTING ACOUSTIC CHALLENGES IN FULLY MULTI-PURPOSE USE SCOUT HALLS

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1 INTRODUCTION

Every child has the right to education, as stated in the UN Convention on the Rights of the Child (UNCRC), Articles 28 and 29[1]. Article 28 recognizes the right of every child to education, and Article 29 of the UNCRC states that a child or young person's education should help their mind, body and talents be the best they can. High quality education supports holistic child development, involving not only the academic knowledge on various subjects, but also physical well-being and emotional resilience. Through education, children learn critical life skills, build confidence, and develop social and emotional understanding.

While schools form the core of formal education, other groups such as community centres, youth clubs, extra-curriculum programmes, etc, play an equally important role in nurturing child's full potential. In the UK, the Scouts and Girlguiding organisations are examples of a broader educational network. Through activities that focus on outdoor and indoor learning, teamwork, leadership, and life skills, Scouts and Girl Guides support pupils' development beyond the classroom. There are over 7,500 Scout Groups across the UK, with 444,682 young people aged 4-18 being engaged in Scouts activities last year (2024). In the same year Girlguiding UK had over 300,000 girls and young women involved, making it the UK's largest youth organisation for girls.

According to "Our Vision" from Scouts UK[2], this organisation "actively engages and supports young people in their personal development, empowering them to make a positive contribution to society". The organisation is widespread across the country, with each unit needing a place to meet. This could be in someone's home, barn or farm building, or parish room, or purpose-built Scout meeting place (hut, or den, or hall, or Headquarters). A scout hall typically consists of one or more large rooms which are used for games and scouting activities, and may also include smaller rooms for committee meetings, storage and a kitchen. Most of the halls in the UK were built in the early to mid-20th century and beyond. Some older buildings, like former schools or community halls, were also adapted for Scout use around the same time. As each individual unit is responsible for their own infrastructure arrangements, there is no central oversight from the wider Scout organisation of the facilities beyond advice on best practice, including in health and safety aspects.

When not being used for scouting, scout halls are often hired to other community groups, in a similar way to a village hall or community centres. The activities held in the halls vary from indoor games to dances, from chat groups to community meetings. Scout halls clearly fall under the definition of multi-purpose spaces.

2 MULTI-PURPOSE HALLS DESIGN GUIDANCE

Multi-purpose halls are defined and widely used in performance spaces[3, 4]. In auditoria design, the term “multi-purpose space” refers to multi-use of the accommodation for different types of music performances rather than broader functionality. Numerous studies, both historical and recent, have explored the impact of architectural features on the acoustical performance of these spaces[3–6]. Various measurable and subjective acoustic parameters are discussed in the literature to improve the acoustics in multi-use halls.

Another popular example of a multi-purpose hall is in primary schools, where they are implemented mainly due to the size of the building and inability to fit more than one large hall into a given footprint. In England, Part E of the Building Regulations[7] covers all spaces used for education within school complexes, including nursery, children’s, adult, and community education. To meet the requirements of Part E4: *Acoustic Conditions in Schools*, compliance with Building Bulletin 93 (BB93)[8] is required. In Scotland, a similar reference to BB93 compliance is included in the British Standards Institution's Non-Domestic Handbook[9].

The design requirements for multi-purpose halls in UK schools are outlined in BB93 and further discussed in the guidance provided by the Institute of Acoustics and the Association of Noise Consultants[10]. The design criteria for various large halls, as set out in BB93[8], are shown below in Table 1 for both new-build and refurbishment schools (refurbishment values are shown in brackets). No additional recommendations are provided in this document specifically for multi-purpose halls. These values are for rooms that are furnished for normal use, but unoccupied.

Table 1. BB93:2015 noise criteria

Room type	Activity/ sensitivity	Upper limit $L_{Aeq,T}$ (dB re 2 x 10^{-5} Pa)	T_{mf}, seconds
Lecture theatre	Average/ Medium	35(40)	≤ 0.8 (1.0)
Sports Hall	High/ Medium	40 (45)	≤ 1.5-2 (2)
Assembly Hall	High/ Low	35 (40)	≤ 0.8- 1.2 (0.8 – 1.5)
Multi-Purpose Hall	High/ Low	35 (40)	≤ 0.8- 1.2 (0.8 – 1.5)
Dining Hall	High/ High	45 (50)	≤ 1.0 (1.5)

The guidance document[10] provides a more detailed discussion of multi-purpose halls, with a particular focus on their use for music performances. It defines a multi-purpose hall as “a single flexible hall required for a variety of uses.” The document also introduces the term “fully multi-purpose hall,” describing it as a space that can cater equally to drama, dance, assemblies, examinations, and similar activities.

Multi-purpose halls are used for various applications, and therefore they are expected to be versatile and flexible: have retractable chairs or benches, foldable tables, moveable partitions, curtains, screens, drop-down sports equipment, demountable entertainment systems, servery hatches and other adaptable elements. These different functions of multi-purpose halls often have conflicting acoustic requirements, making it challenging to design a space that offers optimal acoustics for all intended uses.

Although the above requirements are officially applied only to spaces that are part of educational buildings (as specified in [8]), other types of buildings, such as stand-alone nurseries, sports centres, community halls, and even theatres, are regularly adopting the same standards when undergoing new design or refurbishment processes.

3 DESIGN AND BUILD OF MULTI-PURPOSE HALLS

The most appropriate measurable parameters to describe acoustic conditions within an educational space are ambient noise and reverberation time (RT). It has also become common to address speech intelligibility by assessing Sound Transmission Index (STI), mainly through modelling, rather than measurements. It becomes essential if a large space is used as a set of open plan activity spaces or classrooms. Speech intelligibility is required to be high (≥0.6) for working within each group in an open-plan space and low (≤0.3) between these groups to minimize interference. STI is directly affected by ambient noise and reverberation in the assessed space.

The acoustic parameters for multi-purpose halls set in BB93 are mainly identical to an assembly/ performance hall requirements (see Table 1). The requirements include low noise tolerance, lower reverberation time, low noise levels from mechanical ventilation, and high speech intelligibility. In initial design reports the multi-purpose halls are following the above requirements. Then during the detailed design and development stages, most of such halls are later reassessed and reclassified as mainly sports areas, with high reverberation and low speech intelligibility as an outcome of such design approach. Additionally, the acoustic standards set for multi-purpose halls are more challenging to meet. As a result, exceptions and alternative performance standards are often applied to some of the acoustic parameters. These may include reduced STI targets, increased RT values, higher permissible ambient noise limits, or waivers for wall sound insulation requirements, when features such as servery hatches, movable screens, or internal windows are present.

Some examples of multi-purpose halls' design standards and final measurements are shown in Table 2 (test data provided by Robin Mackenzie Partnership).

Table 2. Examples of Multi-purpose halls: design and test data

Room	Area, m^2	Design T_{mf}, seconds	Measured RT, seconds	Advice given
Location 1 (new built)				
Multi-purpose Hall 1 (expected to use more for performances)	300	≤ 0.8- 1.2	2.05	135 m^2 of Class A acoustic panels
Multi-purpose Hall 2 (expected to use for dining, with server hatch)	300	≤ 1.0	2.29	150 m^2 of Class A acoustic panels
Joined Multi-purpose Hall (expected to use for sport activities)	600	≤ 2.0	2.09	285 m^2 of Class A acoustic panels
Location 2 (refurbishment)				
Multi-purpose hall (used for sports, dining and performance)	200	≤ 0.8 – 1.5	3.2	190 m^2 of Class A acoustic panels

The suggestion of additional panelling, as shown in Table 2, was based on modelling and analytical calculations. It was also understood that in some of these cases the recommended amount of panelling cannot be fitted due to lack of free surfaces within the problematic space.

The above examples suggest that the acoustic design of large spaces in new-build projects must be established and agreed upon prior to the technical and construction design stages and should not be significantly altered later in the process. Failure to maintain this consistency can result in non-compliance and may necessitate costly remedial works at the final stage of the project. Once these spaces are in use, complaints may arise due to poor acoustic performance and the inability of the space to function as originally intended.

For refurbishment projects, advice on improvement should be considered taking into account the limitations of the existing space and available options but still may lead to substantial improvements.

4 CASE STUDY: REFURBISHMENT ADVICE FOR 150TH CRAIGALMOND SCOUT HALL, EDINBURGH

Scout halls can be considered as fully multi-purpose halls and are expected to be used by the host scout groups as well as the wider community. A significant number of such halls is either repurposed existing buildings (such as community centres or old school buildings) or purpose-built prior to or around the mid-1960s, before official technical standards were established for non-domestic buildings. As a result, it is to be expected that these spaces would have poor acoustic conditions, which can significantly limit the range of indoor activities, or make certain uses uncomfortable for users. To help improve the experience of young children and scout leaders in the hall, their acoustic performance should be investigated and addressed.

An agreement was made with the 150th Craigalmond Scout Division in Edinburgh to assess the acoustic performance of their hall and to provide recommendations for improvement, including options for the Scouts to undertake remedial work themselves, where feasible.

The scout hall building for 150th Craigalmond Scout division (shown in Figure 1) is located in Edinburgh West quiet suburban residential area, with two daytime nurseries and a medical centre on the same street.

Figure 1. Scout Hall building exterior and interior

The main building was originally constructed in 1946 and had several refurbishments over the years. The main hall occupies most of the building, with a floor area of approximately 16.1m by 8m. The roof is slightly inclined across the width of the hall, with the ceiling height ranging from 5.0m at the lower end to 5.3m at the higher end. The hall has hard wooden flooring and plasterboard ceiling and walls. There are four 1m x 0.6 m thin absorbing panels located 3m high above the ground (two can be seen on Figure 1), which are assumed to provide some absorption, however their effect is negligible due to their location and nature. The room has a ventilation/ heating system to provide heating in winter, with thermostat control. The heating system was off during the tests.

The number of attendees during the scout sessions varies but could be up to 40 children and adults in the same room. The main indoor activities held in the hall for the scout division are active running games, ball games, dances, baking and crafting activities, as well as various meetings. In addition to the scouts activities the hall is used for yoga, Zumba classes, practices for Rugbytots and martial arts classes.

4.1. Preliminary measurements

The ambient noise level inside the hall with doors closed is measured as 32 dB, which is expected for a quiet area. It would be expected that with heating on, the ambient noise will be higher, closer to 35 dB (required for newbuilt multi-purpose halls) or reach closer to 40 dB (for refurbished) as shown in Table 1. The source noise of activity was also recorded, for a running activity (with 14 pupils present). All measured data are shown in Figure 2.

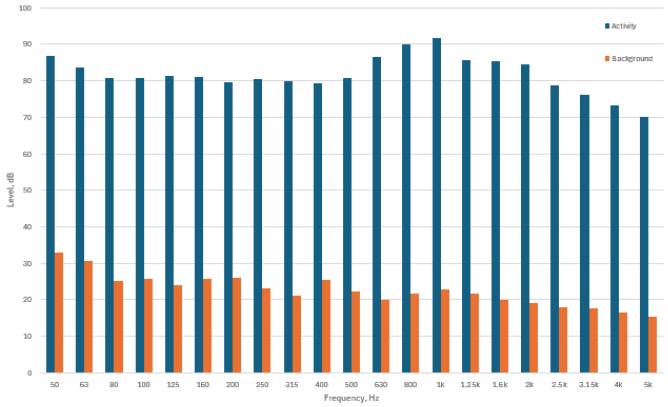

Figure 2. Activity and background noise levels

The reverberation time was recorded in the hall at 8 locations. The averaged RT spectrum and single figure values are shown in Table 3. The single figure is calculated as an average between 500 Hz, 1000 Hz and 200 Hz individual values.

Table 3. Reverberation Time in scout hall, original test (seconds)

Expected RT, T_{mf} as per BB93	Octave Band Centre Frequency (Hz)							Measured RT
	63	125	250	500	1000	2000	4000	
≤0.8 - 1.2	1.27	1.03	1.81	2.26	2.43	2.51	1.77	2.4

The RT measured in the hall is 1.4sec higher than the highest expected level for multi-purpose hall. In addition, the dimensions of the hall (8m by 16.1m) show the likelihood of the appearance of standing waves, particularly at low frequencies (around 90 Hz, 180 Hz and so on), due to the formation of modal resonances between parallel surfaces.

4.2. Advice provided to Scout team

Upon completion of the measurements, analytical calculations were conducted to provide advice for potential improvements. The advice was given in terms of Class A acoustic panels, to cover the area of 48 m^2. This would be expected to reduce the RT levels to 1.5 sec. The panels should cover any free areas on the walls or at least two adjacent walls. The preferred positioning of acoustically absorbent finishes as recommended by [10] is shown in Figure 3.

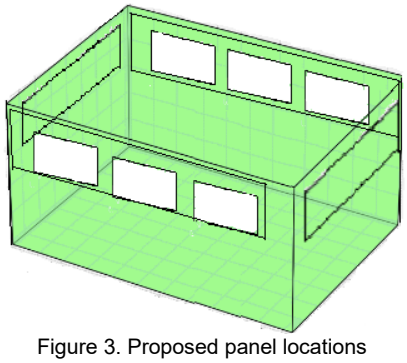

Figure 3. Proposed panel locations

The advice was focused on the treatments which can be done manually or with minimal technical support, to allow the scout group to manufacture their own panels for their space. Although it is expected to have lower performance in comparison with pre-fabricated panels, the idea of building the panels was commended by the scout leader team. An example of the hand-fabricated panels made by scouts are shown in Figure 4.

Figure 4. Acoustic panel from 150th Craigalmond scout centre

4.3. Reverberation time improvements in the hall

Intermediate tests were conducted to demonstrate the improvements with some of the panels (approximately 20m^2) made prior to the summer break. The panels were stood against two adjacent walls (as recommended)
The results of RT re-test are presented in Table 4.

Table 4. Reverberation Time in scout hall, re-test (seconds)

Expected RT, T_{mf} as per BB93	Octave Band Centre Frequency (Hz)							Measured RT
	63	125	250	500	1000	2000	4000	
≤0.8 - 1.2	1.2	0.94	1.58	2.0	2.1	2.0	1.6	2.0

The comparison of reverberation times before and after initial treatment is shown in Figure 5.

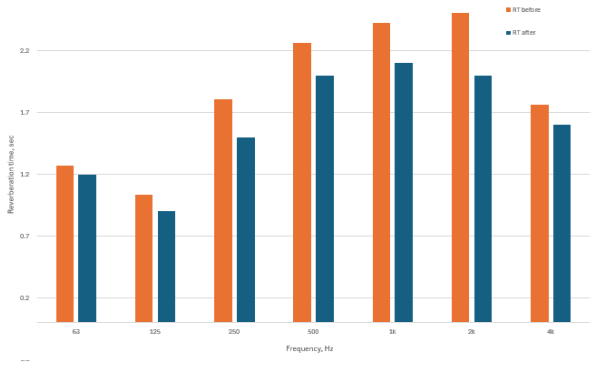

Figure 5. RT comparison

The introduced panelling presents a reduction of reverberation at medium and higher frequencies with minimum effect on the low frequency range due to the limitations imposed by the panels' construction and depth. The current RT as measured meets the requirement for refurbished Sports Halls (as set in Table 1), however the main project aim is to reduce it further to achieve the requirements for refurbished Performance/ Multi-purpose space. It is also expected that the standing waves should be affected by the presence of panels acting as sound absorbing and scattering elements on non-parallel walls. Further work is expected from the scout team to manufacture the remaining panels.

5 FURTHER WORK: IMPROVEMENTS FOR CHILDREN WITH SPECIAL EDUCATIONAL NEEDS

According to Educational Statistics[11], there has been a 5.6% increase in the number of pupils with Special Educational Needs (SEN) in 2024, continuing a long-term upward trend. The Scouts organization is open to all individuals who wish to participate, and its activities and programmes are flexible and inclusive, designed to meet a wide range of needs. Individual plans should be developed to provide appropriate support, and include reasonable adjustments such as ramps, noise-cancelling headphones, hearing induction loops, or other assistive accommodations for pupils and staff.

The guidance and requirements documents[8, 10] contain advice on enhanced acoustic performance for teaching spaces intended specifically for pupils with special hearing and communication needs. Although these recommendations are not mandatory for non-educational buildings like Scout halls, the principles of improved acoustic performance are highly relevant there and can be applied to create more inclusive and supportive environment for all participants, especially those with additional needs.

To support the design and refurbishment needs of community spaces, the guidances applicable to school buildings should be extended to cover other spaces used for educating children.

6 ACKNOLEDGEMENTS

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I also would like to thank my colleagues at Robin Mackenzie Partnership, Edinburgh Napier University, for providing the site testing data, and equipment for tests for this work.

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