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Fitter's Workshop

Acoustic Assessment

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EXECUTIVE SUMMARY

SLR Consulting have conducted a review of the acoustic qualities of the Fitter's Workshop at Kingston ACT.

The objectives of the brief were to look at the following:

- the acoustic qualities and characteristics of the Fitters' Workshop building, Kingston Arts precinct
- whether the building may have any identifiable unique acoustic qualities which make it a superior venue for live music and/or choral performance
- possible or likely alteration to any unique existing acoustic qualities that could result from changes (such as fitting out) to the current 'bare' nature of the building.
- comparison of the space to other venues of similar size with high reverberance eg a school gymnasium

Technically there are a number of factors which influence music production in a building. These include:

- building geometry especially relative dimensions of the walls in rectangular spaces
- surface finishes
- surface irregularities or diffusive elements

In terms of surface finishes, the building is currently very unusual in that walls, floor and ceiling consist of entirely hard acoustically reflective surfaces, and the ceiling is over 7 metres high. This combination of attributes gives the building its exceedingly live and reverberant characteristics.

The building dimensions are approximately 42m x 12m x 7.6m. Testing of the space revealed reverberation times of up to 5 seconds in the lower frequencies, 10 seconds in the mid frequency range and 5 seconds in the high frequency range. By comparison, testing of a local school gym of similar volume with predominantly hard surfaces produced reverberation times of 3.5 seconds, 3.2 seconds and 2.3 seconds in the low , mid and high frequency ranges respectively. Clearly the space is unusual in its liveness and would suit performers wishing to achieve a warm, sustained sound without artificial electro-acoustic enhancement.

In terms of the appeal or potential uses of the building, recourse was made to a survey of many different venues cited in Beranek (1). In this study, conductors listed their favourite venues for different genres of classical music. Reverberation times for the different favourite spaces ranged from 1.5 to 2.1 seconds. The reverberation time of this space is well in excess of the range of desirable reverberation times in the study.

On the basis of reverberation alone, there is probably no similar space currently available in the ACT. However the space appears to be limited to a narrow range of musical performances due to these unusual characteristics. The decision appears to centre on whether the Fitter's Workshop should be kept vacant to suit a minority of situations or be adapted for more permanent regular use.

1 INTRODUCTION

As the name suggests, the Fitter's Workshop was originally built for industrial use. It is a rectangular building of approximate dimensions 41 metres long, 12 metres wide and a ceiling height of 7.5 metres at the lowest point.

In the recent past the building was used for storage, with the mobile crane being the only equipment retained from the previous use. The building is now empty. Internally it consists of entirely hard surfaces, rendered brick walls, concrete floor, timber doors, plaster ceiling and glass windows.

This makes for a highly live (reverberant) space, similar to a cathedral. The space has been used for musical performances. Anecdotally it is reported that some eminent musicians have given the workshop endorsement as a unique space in which to play music.

The purpose of this study is to provide some objective means of assessing the Fitters Workshop according to the following terms of reference:

- Investigate the acoustic qualities and characteristics of the Fitters' Workshop building, Kingston Arts precinct
- Determine whether the building may have any identifiable unique acoustic qualities which make it a superior venue for live music and/or choral performance
- Advise of the possible or likely alteration to any unique existing acoustic qualities that could result from changes (such as fitting out) to the current 'bare' nature of the building.
- Compare the space to other venues of similar size with high reverberance eg a school gymnasium

2 ASSESSMENT METHODOLOGY

2.1 Reverberation Time

SLR Consulting visited the Fitter's Workshop to inspect the space and conduct some reverberation time testing. The resulting reverberation time measurements were compared to predicted reverberation times using Sabine Calculations for the size and surface finishes of the space in order to calibrate the model.

The reverberation times in the Fitter's Workshop were then recalculated based on varying audience sizes. The acoustics of Fitter's workshop was also compared with another potential venue, a school gym of similar dimensions. This alternative venue is also a relatively live or reverberant space, therefore it is worthwhile to evaluate such as space in view of the claims of "uniqueness" which have been attributed to the Fitter's Workshop.

In order to determine the merit of the Fitter's Workshop as a music venue, a literature search was made of relevant publications. In addition to the question of uniqueness there is also the question of usability. How beneficial the space is to a range of musical performances may be important in deciding whether it should remain in its current form.

2.2 Modal Analysis

The Fitter's workshop was also analysed with respect to the likely reinforcement and distribution of sound due to the building's geometry. Ideally, it is desirable that the building reinforce sounds evenly i.e. there should not be a marked reinforcement of any particular frequency. The most basic form of reinforcement occurs at wavelengths which are an exact multiple of one of the building's main dimensions. Other more complex modes occur as a result of the interaction of several surfaces in the building.

3 ASSESSMENT CRITERIA

There are few assessment criteria applicable to this situation, since we are dealing with the aesthetic nature of the sound rather than questions of noise level. AS2107:2000 *Recommended design sound levels and reverberation times for building interiors* provides some limited guidance in the form of a graph of mid frequency reverberation times (500 Hz and 1000 Hz) versus room volume. This graph is shown in **Figure 1**.

Figure 1 Recommended Mid Frequency Reverberation Times vs Room Volume

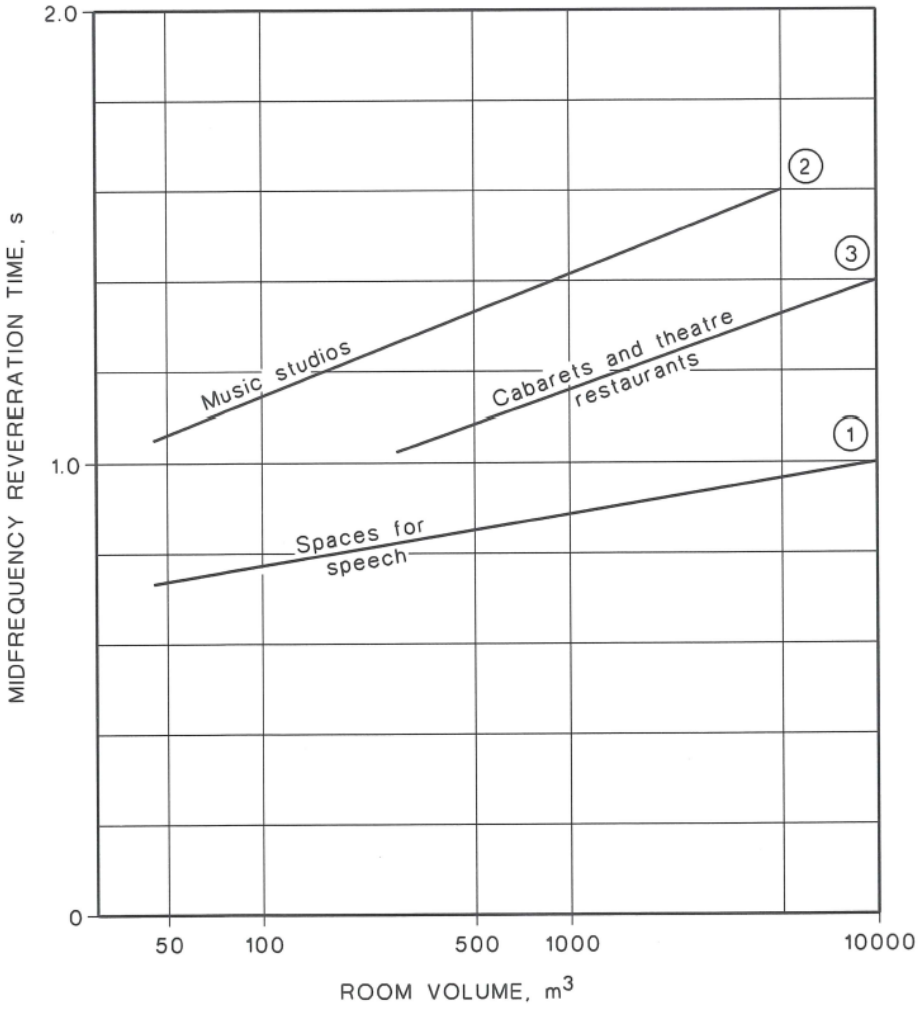


FIGURE A1 MEAN REVERBERATION TIMES

In the body of the document it is noted that the graph is intended as a guide only as practically speaking the spread of acceptable solutions is large. From this chart, based on a room volume of approximately 3700 cubic metres, the reverberation time at 500 Hz and 1000 Hz is recommended to be in the order of 2.5 seconds to 3 seconds.

4 RESULTS

4.1 Reverberation Times

4.1.1 Fitters Workshop

Reverberation times were taken based on balloon burst measurements within the building at various locations. A Rion NA 28 Sound Analyser was used for the measurements. **Table 1** presents the reverberation time data.

Table 1 Reverberation Times – Fitters Workshop

Reverberation Time, (Seconds)							
63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
2.0	5.2	8.0	10.2	9.8	7.5	5.1	2.4

4.1.2 Local School Gymnasium

Reverberation times were taken based on balloon burst measurements within the building at various locations. A Rion NA 28 Sound Analyser was used for the measurements. **Table 2** presents the reverberation time data.

Table 2 Reverberation Times – School Gymnasium

Reverberation Time, (Seconds)							
63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
2.5	3.7	3.5	3.2	3.2	2.9	2.3	1.3

4.1.3 Changes to Reverberation Time with Audiences

Once an audience has been added to the space, the reverberation time will decrease proportionally to the increase in audience numbers. **Table 3** shows predicted decreases in the reverberation times with increasing audience sizes.

Table 3 Reduction in RT with increase in audience

Predicted Reverberation Time, (Seconds)							
Audience	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**
10	2.1	4.7	10.0	8.4	6.2	5.4	2.1
20	2.1	4.5	9.2	7.7	5.8	5.1	2.1
40	1.9	4.0	7.7	6.4	4.9	4.2	1.9

4.2 Modal Analysis

The modal analysis is provided using Amroc software. **Figure 2** shows the distribution of modes within the Fitter's Workshop. The lines increase in height according to the number of modes within a narrow frequency range. It can be seen that the spread of modes is quite even, which is a desirable characteristic. According to Bonello (2) it is also desirable for the number of modes per third octave band to steadily increase as the frequency increases. **Figure 3** shows that this trend is also occurring.

Figure 2 Room Modes in Fitters Workshop

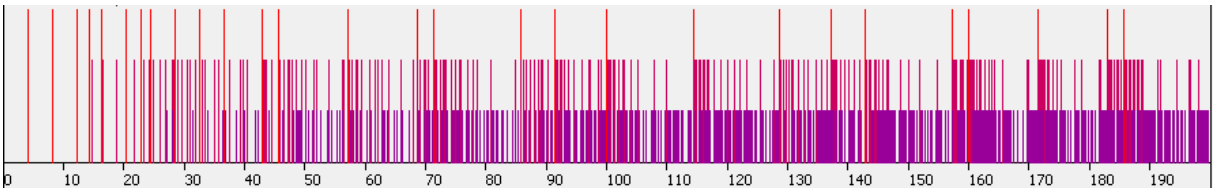
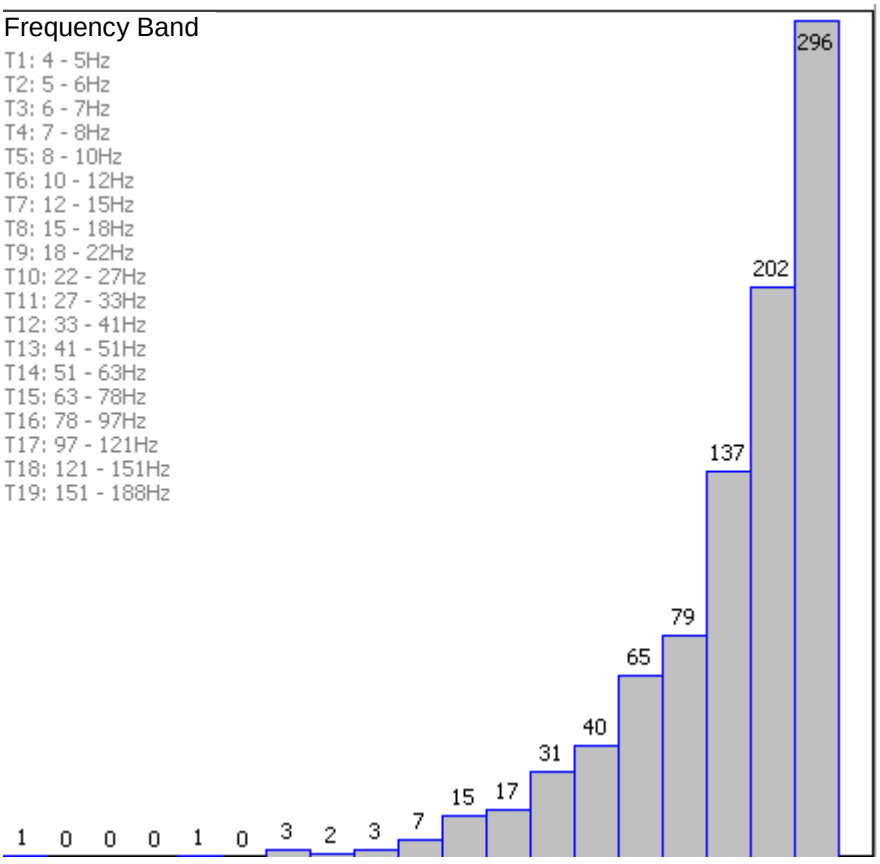


Figure 3 Modes per one-third octave (Bonello Criterion)



4.3 Literature Review

Beranek (1) provided an in-depth study of concert halls around the world. This research work is very comprehensive and only a small excerpt was considered in reference to this project. In one survey referenced in this book, the ideal range of reverberation times for orchestral works was given as 1.5 to 2.1 seconds. Elsewhere in this volume, reverberation times of 5-10 seconds are described as being similar in performance to a medieval cathedral.

5 DISCUSSION

The gymnasium measured had a similar cubic volume to the Fitter's workshop at approximately 4000 cubic metres compared to 3700 cubic metres. From the reverberation time measurements it is clear that the Fitter's workshop is unusual (if not unique) in the amount of reverberation it provides. This is most likely due to the desire in most cases for buildings of significant area to support a variety of uses. For example, reverberation times of 10 seconds in the mid frequency range are highly undesirable for speech intelligibility. This is easily demonstrated by trying to communicate within the Fitter's workshop with only a few people present.

In terms of the uniformity of sound reinforcement there is a good spread across the frequency range. The effect of this is basically to amplify and sustain the sound with little distortion or favouring of a particular frequency. The large supports for the crane rails may be helping to scatter the sound and improve the overall distribution of sound within the space. This said, some "flutter echo" was also observed which occurs when sound waves bounce rapidly between the walls, resulting in some harsh echoes depending on the position of the sound source in the room.

It can be said that in certain respects the Fitter's Workshop is a rare if not unique place to make music. The more significant issue appears to be under what circumstances would a musician wish to use the building, and what kinds of music are the most advantageous to play there. The technical data suggests that the hall would be best suited to works which rely on a rich sustained sound, where the different notes blend together. Based on Beranek's review of concert halls, this space is not suited to classical music due to the very long reverberation times.

If the building was to be fitted out for other uses, it is inevitable that the current reverberant (live) nature of the building will be diminished. This is because the introduction of furniture and partitions will segment the space and therefore decrease the effective volume of any single area within the building. The introduction of soft furnishings would also further decrease the liveness.

In view of the results obtained, the utility of the Fitter's workshop for musical performances appears to be limited to a very specific style of music or taste for the way the building will reinforce the sound. The consideration would then be whether this building should be set apart for this particular interest or be repurposed to address the needs of a broader cross-section of the community.

6 CLOSURE

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

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SLR Consulting disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

7 REFERENCES

1. Beranek, Leo: “How they sound Concert and Opera Halls” - Acoustical Society of America (1996)
2. Bonello, Oscar J.: "A New Criterion for the Distribution of Normal Room Modes" - AES-Journal(USA) 29 (1981)