Proceedings of The Institute of Acoustics

ACOUSTIC CONDITIONS FOR PERFORMERS IN DUKES HALL, ROYAL ACADEMY OF MUSIC

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INTRODUCTION

The Royal Academy of Music on Marylebone Road was built in 1910. It contains a 500-seat concert hall (the Dukes Hall) which is to be refurbished in 1988. The hall is approximately 30m long and 14m wide and has a barrel vault 15m above floor level at its highest point. There is a small balcony at one end of the hall. At the other end is a high, flat orchestra platform with steeply-raked benches behind leading up to an organ in front of the end wall. The hall is used mainly for orchestra and choir rehearsals or for performances in the presence of very small audiences. Only occasionally is a concert performed to a full house. The hall is also used for aural examinations where soloists and small groups perform to a small audience of examiners. Clearly, this is a hall where the acoustic conditions for the performers are more important than those for audiences.

This paper describes the design of a questionnaire which has recently been circulated amongst musicians at the Academy. The objective of this questionnaire survey is to find out what the acoustic requirements of the Academy's musicians are when they are performing and how the platform of Dukes Hall rates in terms of these requirements. It is hoped that the survey results will assist in the analysis of acoustic conditions on stage and provide a concensus "before improvement" view for comparison with survey results obtained after the refurbishment is completed.

LITERATURE SURVEY

A vast number of books and papers have been written on the subject of concert hall acoustics. Only comparatively recently have the acoustic requirements of the musician begun to be considered. Where reference has been made to the musicians subjective requirements[1,2,3,4,5,6], the comments can be divided into three main groups:

The need for musicians to "hear one another"
The musicians' perception of "sound quality"
The effect of auditorium acoustics on performance

In 1981, Gade [7] conducted an interview survey among professional performers of classical music in Denmark. He interviewed 32 musicians, representing the most common of orchestral instruments. Based on the musicians' statements, he derived seven subjective

room acoustic parameters which he believed covered musicians' perception of room acoustic qualities. These are (ordered according to the number of musicians who noted them):

HEARING-EACH-OTHER: (noted by 31)
REVERBERATION: (noted by 29)
SUPPORT: (noted by 27)
TIMBRE: (noted by 23)
DYNAMICS: (noted by 20)
TIME DELAY: (noted by 9)
CHANGE OF PITCH: (noted by 3)

Gade found that amongst conductors and orchestral players, the parameter of primary importance is the ability to hear each other. To soloists, the parameters which determine the sound quality are the most important, ie; reverberation, support, timbre and dynamics. 81% of the musicians interviewed considered acoustics to be of major importance to the musician. 63% felt that acoustic awareness and the ability to adjust one's playing/singing to the acoustics of the hall was a matter of experience. Consequently, great care should be taken in the acoustic design of music schools.

QUESTIONNAIRE DESIGN

The selection of questions for the Dukes Hall questionnaire survey has been based on Gada's findings, summarised above. The respondent is asked for his/her reaction to each of Gade's parameters with the exception of "change of pitch" which was only mentioned by 3 out of 32 musicians. Questions covering three additional parameters have been included:

ECHO - whether discrete late sound reflections can be heard.
BACKGROUND NOISE (Dukes Hall has windows which overlook the busy Marylebone Road in Central London and is situated close to an Underground line and consequently has a high background noise level).
OVERALL IMPRESSION

Two questionnaires have been devised, based on questionnaires used by other researchers [Naylor, Bradley, Gade and Barron]:

GENERAL QUESTIONNAIRE: (reproduced at the end of this paper).
In this questionnaire the respondent is asked to rate the importance of the parameter to him/her as a performer and then to rate Dukes Hall in terms of each parameter.

PERFORMANCE QUESTIONNAIRE:
This shorter questionnaire is designed to be answered immediately after performing in Dukes Hall and asks the respondent to rate the hall in terms of each parameter for that occasion only.

A graphical rating scale has been used to collect responses. The ends of the scale are described by adjectives which are polar opposites and the respondent is asked to assess the degree of each attribute by placing a mark somewhere on the scale. Although a scale without subdivisions can be criticised on the grounds that some respondents find it easier to identify a limited number of shades of opinion, corresponding to scale divisions, it has the advantage that no restriction is placed on respondents who may wish to express an in-between view.

Some performer questionnaires include questions on non-acoustic factors. so that the respondent's views on acoustics can be weighed against those on other factors and an overreaction in favour of acoustics avoided. This approach has been rejected here as it would enlarge an already long questionnaire and, in any case, it is the relative importance of each parameter that is of most interest, not the absolute rating. Therefore only one such question is inculded on the general questionnaire.

CIRCULATION OF QUESTIONNAIRES

For statistically meaningful results, it is desirable to circulate the questionnaires to as large a number of respondents as possible. For practical reasons, it has been necessary to restrict the number. Completed questionnaires have been received from 39 musicians: 22 student orchestra members (11 strings, 4 woodwind, 4 brass, 3 percussion), 9 student choir members and 8 members of staff, including 5 conductors. With the exception of the choir, all student respondents are at least in their second year of study. Each has completed one general and one performance questionnaire.

ANALYSIS OF QUESTIONNAIRES

The proposed number of respondents is rather small and consequently elaborate statistical analysis is not appropriate. Mean responses to parameters are simply rank ordered according to importance to the total sample and to groupings within the sample. The responses relating specifically to Dukes Hall are expressed as mean responses to each parameter for the total sample and for groupings within the sample. The main findings from this small survey follow.

General questionnaire, "importance" questions

The parameters were ordered according to mean importance for the whole sample and for three groupings; orchestra, choir and staff. All groups rated good acoustics as important. In all cases, "dynamics" - the ability to achieve pp or ff with ease - proved to be the parameter of greatest importance to the respondents and "hearing each other" rated second. "Reverberation" and (avoidance of) "echoes" were considered by the orchestra and choir to be the least important of the eight parameters.

In general, the respondents gave greater priority to control of dynamics than was found by Gade's survey. Not every group followed this pattern. The six violinists were a notable exception, rating "support" as the parameter of greatest importance and relegating "hearing each other" to fifth position. The percussionists (3 No) rated "background noise" as the parameter of greatest importance. From the staff sample, the conductors rated "hearing each other" and "background noise" in equal first position.

Both questionnaires; rating of Dukes Hall platform
Results obtained from the general questionnaire tended to repeat themselves in the performer questionnaire except for the "background noise" scale on which the majority of respondents rated the background noise much lower when assessed immediately after a rehearsal in the hall than they had when they were not in the hall. This may be because they responded to the general questionnaire more as listeners than as performers.

The general tendency was for most of the parameter scales to be given a neutral rating by all groups. The overall response was that existing conditions are "fair", though staff and percussionists rated conditions as poorer. All but two orchestra members felt that there was an imbalance on the platform. The brass and percussion sections find it easy to achieve ff and, consistently, the orchestra members tend to find the brass and percussion too loud. Most of the orchestra felt that an imbalance on the platform did affect rhythmic precision and/or intonation.

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DUKES HALL, ROYAL ACADEMY OF MUSIC

ACOUSTIC CONDITIONS FOR PERFORMERS - GENERAL QUESTIONNAIRE

Respondent

Name: _____

Year of course (if student): _____

Instrument: _____

Musical role: [Tick appropriate box(es)]

Orchestra member	[ ] O
Ensemble member	[ ] E
Choir member	[ ] Ch
Soloist with orchestra	[ ] S/O
Soloist with piano accomp.	[ ] S/P
Conductor	[ ] C
Tutor	[ ] T

(See instructions for an explanation of use of abbreviations.)

General question

How important are acoustics to you as a musician when compared with other factors which affect performance?

No importance ——————————— Supreme importance

ACOUSTIC ATTRIBUTES

1 **Reverberation**

(Definition: the decay of sound in the room following each note; the "blurring" effect between successive notes.)

How important is reverberation to you as a performer?

No importance ——————————— Supreme importance

For performance, is Dukes Hall

Much too "dry" ——————————— Much too reverberant?

2 **Support**

(Definition: ease of playing; "attack"; no need to "force" the instrument or voice to sustain a good sound)

How important is support to you as a performer?

No importance ——— Supreme importance

When you play in Dukes Hall, how much support do you receive?

No support ——— Very easy to play

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3 **Hearing each other**

How important is it to you as a performer to be able to hear all the other performers on the platform?

No importance ——— Supreme importance

In Dukes Hall, do you find your own instrument or voice

Inaudible ——— Much too loud?

In Dukes Hall, do you find others in your section

Inaudible ——— Much too loud?

In Dukes Hall, do you find other sections

Inaudible ——— Much too loud?

If there is an imbalance;
Which sections or instruments are usually insufficiently loud?

_____

Which sections or instruments are usually too loud?

_____

Does the imbalance affect rhythmic precision? [ ]
intonation ? [ ]

(Tick box as appropriate).

4 **Timbre**

(Definition: sound colour)

How important is the timbre of the sound received on stage to you as a performer?

No importance ——— Supreme importance

In Dukes Hall, what is the timbre of the sound like on the platform?

Very cold/hard ——— Very rich mellow

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5 **Dynamics**

How important is it for you to be able to produce pp or ff with ease when performing?

No importance ——— Supreme importance

In Dukes Hall, how easy do you find it to achieve pp?

Very easy ——— Very difficult

In Dukes Hall, how easy do you find it to achieve ff?

Very easy ——— Very difficult

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6 **Time delay**

How important is it for the time delays between the various performers on the platform to be very short?

No importance ——— Supreme importance

When performing in Dukes Hall, how do you find the time delays between performers?

Not noticable ——— Excessively long

7 Echo

(Definition; a discrete sound reflection heard as a separate event.)

When you are performing, how important is it that you can hear no echoes?

No importance ---------- Supreme importance

When performing in Dukes Hall, can you hear any echoes?

No echoes ---------- Very strong echo(es)

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8 Background noise

How important is it to you not to hear any background noises when performing?

No importance ---------- Supreme importance

In Dukes Hall, do you find the background noise

Inaudible ---------- Intolerably loud?

List the disturbing noise sources, if any.

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9 Overall impression

When performing in Dukes Hall, do you find the acoustic conditions

Poor ---------- Excellent?

Any further comments?