# Acoustical Problems in Orchestra Pits; Causes and Possible Solutions

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On the basis of a study carried out by the authors on acoustic problems in the orchestra pit in The Royal Opera in Stockholm, this paper discuss possible reasons and solutions to the problems found in many orchestra pits today. The study in Stockholm included a survey in which questionnaires were distributed to a large number of other opera houses around the world. From this survey it has been possible to extract general knowledge about 1) the physical lay out and 2) the extent of problems in orchestra pits. It has also been possible to find certain relationships between the two. In particular, the available area per musician seems to be an important factor: problems with excessive loudness and difficulties in ensemble playing are more frequently found in pits allowing less than 1.5 $m^2$ per musician. On the other hand, it is likely that changes in performance style and developments in instrument technology over the last half century are the main reasons for some of the problems encountered. Consequently, physical changes to the hall alone may bring only limited improvement – absorption treatment can even have negative effect. Conscious changes in musicians' attitude regarding choice of instruments and performance style are probably the only lasting solutions to these problems.

## INTRODUCTION

In the Royal Opera in Stockholm – like in many other opera houses – excessive sound levels are regarded a major problem for the pit orchestra members. As one of the means to approach this problem, the president of the resident opera orchestra, Hovkapellet, John Kapenekas, in 1998 initiated a questionnaire survey among other opera houses to collect data regarding conditions and problems in other orchestra pits. The hope was that the information so obtained could reveal possible causes and perhaps solutions to the problems in Stockholm. In 1999 a group consisting of the three remaining authors of this paper were asked to suggest possible solutions to the problems. Besides our acoustic experience, Tommy B. Andersson, being a conductor of profession, brought knowledge to our work from his studies on how performance practice have changed over years. In the following, hypotheses and results of general interest from this project will be presented and discussed.

## PIT PROPERTIES AND PROBLEMS

Questionnaire forms were returned from 46 opera houses all over the world with information about the geometry and construction of the pits, the pattern of use and about eventual acoustic problems.

Among the 46 halls, 61% were designed specifically for opera while another 22 % were originally drama theatres. The halls can be characterized briefly by the statistics shown in **Table 1**.

**Table 1** Statistics for the 46 halls regarding their age, size and frequency of use for opera and musical performances

| Statistic | Average | Min. | Max. |
|---|---|---|---|
| Building age (years) | 94 | 8 | 254 |
| # seats | 1334 | 260 | 3100 |
| # performances / year | 107 | 15 | 310 |
| # different perform./year | 13 | 1 | 58 |
| # different perform./week | 3.2 | <1 | 7 |

Details regarding the orchestra pits are listed in **Table 2**.

**Table 2** Details about the orchestra pits in the 46 halls

| Statistic | Aver. | Min. | Max. |
|---|---|---|---|
| Max. area of pit floor ($m^2$)[1] | 109 | 30 | 300 |
| Floor area under forestage [2] | 37 % | 2 % | 80 % |
| Pit floor depth rel. stalls floor[3] | - 2.3 m | 0 m | - 4.5 m |
| Max. # of musicians in pit | 72 | 15 | 110 |
| Pit area / musician ($m^2$) | 1.7 | 0.91 | 2.1 |

[1] In 55 % of the halls, the pit size can be reduced.
[2] These data relate to halls in which the pit is partly under the forestage. (The remaining 13 % of the halls had fully open pits.)
[3] In 15 % of the halls, the pit floor is at the same level as the stalls floor.

In 75 % of the halls the depth of the pit can be changed and 85% of these halls use this possibility. In general, the high pit position is reported to be selected for Mozart and other operas requiring only a moderate sized orchestra. (As these smaller ensembles do not need the space under the forestage – or to be attenuated in a deep, covered pit - it is recommendable to bring the orchestra further up, resulting in better contact between stage and pit and improved fullness of the orchestral sound - especially from the strings.) Regarding surface materials, all but two halls had a pit floor made of wood, and in 70 % of the halls wood was also chosen for most of the pit wall surfaces. Other wall materials are concrete, bricks and gypsum board (mentioned in order of frequency of use).

The opera managements were asked whether one or more of five different problems were experienced in their pits and whether screens and personal hearing protectors were used by orchestra members. The answers are listed in Table 3 along with the percentage of positive answers.

**Table 3** Problems addressed in the international pit survey and percentage of halls answering to the affirmative

| Problem | "Yes" |
|---|---|
| Lack of space | 68 % |
| Difficulties arranging orchestra seating | 48 % |
| Excessive sound levels | 69 % |
| Difficulties hearing other orchestra members | 46 % |
| Lacking quality of the sound | 36 % |

To reduce noise levels screens between musicians are used in 23 % and hearing protectors in 48 % of the halls. (Actually, screens are less often used in crowded pits which have no extra room for them !)

It is quite alarming that lack of space and excessive sound levels are experienced in two out of three opera houses. Many possible reasons for this come to mind: in our modern, noisy and health oriented society we are much more sensitive to work environmental issues than earlier generations, conductors and audiences - influenced by the playing style in American orchestras - demand more powerful expressions nowadays, the size of orchestras have increased beyond what the old halls can accommodate or instruments are being developed towards generating more acoustic power. Which of these are true is not clear today. E.g. there are many testimonies that modern wind and percussion instruments being more powerful than those used a few decades ago; but no documentation seems to exist.

In the search for answers, it was attempted to test for differences in mean values of the physical data belonging to the "yes" and "no" group respectively. However, the variance in the numerical data was obviously too large for any significant relationships to appear. Still, it seems relevant to show the fairly large differences that were observed between the average space per musician in pits with "Yes"- and "No"-answers respectively.

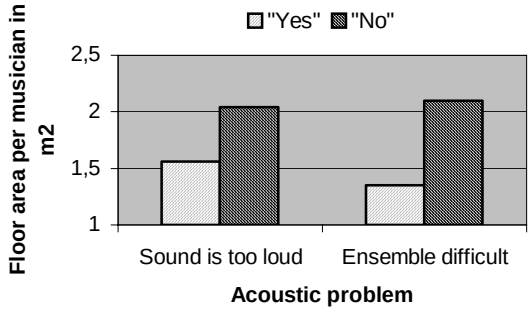


**Figure 1**: Average floor area per musician in pits with and without reported acoustic problems.

## DISCUSSION: POSSIBLE SOLUTIONS

As seen, there is a strong indication of pit size being a parameter influencing level and ensemble problems. If enlarging the pit can be considered, it is better to extend it into the stalls area – by removing one or more seat rows - than by extending it under the forestage. The alternative might be to limit the number of musicians in the pit by planning the season program with the size of the hall in mind since it is also very important to maintain a proper balance between the overall size of the room and the size of the pit and orchestra .

Traditional thinking might lead one to recommend absorption treatment on the wall surfaces in the pit. However, objective measurements in the Royal Theatre in Copenhagen have clearly shown that the result will be reduced acoustic support to the musicians ($ST_{early}$) whereas total level (G) remains almost unaltered. Besides, the musicians are more likely to play too loud if they can't hear themselves, have no sense of balance with their colleagues or feel no response from the hall. Therefore, if possible, increasing reflections in the pit and reverberation in the hall are much better ideas.

However, re-thinking some current trends in performance practice might be much more efficient in overcoming the current problems in orchestra pits - as will be discussed during the aural presentation.