A study of improvements to acoustical conditions for singers

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Abstract: While numerous recent studies have been reported on improving stage acoustics for orchestral performers, the preferred acoustical conditions on performing stages for singers has received limited attention in the past 30 years. A series of acoustical modifications have been proposed for a Seattle church to improve the acoustics for both the listeners and the performing choir. An investigation is on-going, within the constraints of the existing acoustical environment of the church, to determine what direction the acoustical modifications should take to improve conditions of ensemble and balance among the singers, while simultaneously improving the sound field for the audience. Acoustical conditions have been modified both by adding temporary reflecting panels and introducing simulated reflections with strategically located loudspeakers. The initial results indicate a potential for noticeable improvement in the existing chancel acoustics, with most of the benefit applying to the singers rather than the listeners.

INTRODUCTION

A series of acoustical studies are now under way at a Seattle church, both to prepare recommendations for permanent improvements to the current acoustical conditions for the church choir and also as a pilot investigation for a planned series of laboratory simulation experiments to investigate singer's preferences over a full range of acoustical environments. This preliminary investigation seeks to determine the detectability and preferred energy level of early reflections. Singer/subjects will evaluate subjective preference for paired acoustical conditions while performing as a soloist, in small ensembles, and in a full choir. This study will be used to determine future procedures for training singers in later studies with totally simulated sound fields. The results of these preliminary studies may also lead to alternate methods for evaluating subjective response data where bone conduction masking is present.

Previous studies [1] have found that singers feel at ease in performing and are better able to hear each other when the presence of reverberation is strongly felt, with early reflections providing only a minor, positive effect in the preference judgment of simulated sound fields. These studies, however, appear to have simulated the relative energy of early reflections, compared with subsequent reverberation, at a fairly low level, which may account for the minor role of early reflections in the subjective preference ratings by the singers [2, 3, and 4].

EXISTING ACOUSTICS

The studies of acoustical preference are being conducted on an existing stage (the Chancel) at a medium sized church (seating 600), near the University of Washington. This church is often used for musical recitals and is the home for one of the most well-respected church choirs in the metropolitan area. Numerous acoustical deficiencies have been observed for singers at this church and for listeners in the church seating area. An improved acoustical environment for singers is being explored, which will support the artistic demands for balance, blending, and coordination among soloists and between vocal part ensembles. In a questionnaire survey of over 50 singers from the choir, most reported that the acoustical environments in which they perform have a very strong influence on the quality of their singing and a significant effect on their ability to hear each other.

The reverberation measured at the choir area, in the empty church, is in the 1.8 to 2.2 second range, at mid-frequencies. When the choir is present, the reverberation time drops dramatically, by 20% or so, far more than can be explained by the relative increase in total diffuse field sound absorption in the church. To adjust the study environment to match the usual full-choir reverberation, sound absorption will be added to reduce the relative level of reverberation in subsequent preference testing.
PROPOSED MODIFICATIONS

The acoustic environment of the performing stage (the chancel area of the church) will be modified by installing moveable acoustical panels designed to reflect sound back to the choir from the rear wall and side walls with shorter time delay than the existing ceiling corners. See Figure 1. The ceiling corner reflections are currently weakened both by distance and by scattering and absorption in the organ lofts flanking each side of the upper choir. The panels will be 120 by 240 cm (4 by 8 feet) and will be adjustable. The estimated increase in early reflected energy (arriving within 30 ms) will be approximately 4 to 5 dB with deployment of the reflecting panels.

Figure 1. Section across the choir end of the church.

RESULTS OF INITIAL SINGER'S PREFERENCE TESTS

A temporary sound system was used to simulate the addition of the overhead adjustable panels. The system had variable gain and variable time delay, with loudspeakers located to the left side of the singers. A range of natural delays and sound pressure levels was introduced and the singers preference responses collected. Gain levels were also introduced which were higher than those which can be achieved with passive reflectors, providing additional data by extending the subjective preference range of the investigation.

With seven singers evaluated so far, all but one preferred an increase in the strength of the side reflections. A slight preference was noticed for a speakers elevated at a 45 degree angle rather than horizontally to the side. At a gain level equal to the expected level from reflection panels, preferences were not significantly different from a zero gain condition, due to the presence of existing reflections. A gain increase of the simulated reflection of 5 dB established the consensus preference. When the absorption is added to reduce ambient reverberation, natural gain levels are expected to produce a similar consensus of preference. A temporary installation of reflecting panels for the full perimeter of the choir is planned as a follow-up with the full choir participating.

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REFERENCES