

## Solving speech intelligibility in mosques using modern technology

### Introduction

After the extensive work with the State Mosque in Qatar, we have observed that speech intelligibility is a common problem in mosques, and often due to:

- a. Lack of sound absorbing surfaces, in comparison to many sound-reflecting surfaces, can create many acoustic problems.
- b. The internal structure of the building often creates sound problems.
- c. Use of old, wrong and mismatched sound equipment.
- d. Lack of understanding of acoustic problems.

### Acoustics

As mentioned above a common problem is the extensive use of hard surfaces, marble, stone, glass etc., which often result in too long reverberation time (RT60). A long reverb time will seriously affect the clearness of speech – STI (Speech Transmission Index). STI has a value between 0 and 1, and a higher value is better. Usually 0.5 is acceptable but rarely found in a big mosque.

As written by Zerhan Karabiber at Yildiz Tech Univ. there are three distinct acoustical requirements for mosques:

- to hear the namaz (prayer) orders of the Imam (prayer leader),
- to understand the sermon of the preacher,
- to listen to or join to the recital of the musical version of the Holy Koran.

Therefore, at the design of a sound system, it is important to use a good simulation data program. Here a model of the building is made with a computer program. By using a good simulation technician, different materials, shapes and speakers can be tested in the computer model and with good accuracy to real life, if the model is well designed for its purpose. The most common program used is EASE, a program we have used successfully with the State Mosque in Qatar, as well as many other similar projects.

The architect is often focused on his problems and targets, which are to design a beautiful mosque. He is not so often aware of the acoustic problems he might cause.

The most common problem is too long reverberation time RT60. Also the RT60 is higher in the lower frequencies, easily reaching several seconds. The optimal RT60 for mosques and cathedrals of the same size as the State Mosque in Qatar is below 4-4.5 seconds. If speech is the only source an even shorter RT60 is recommendable in order to keep the speech intelligibility as high as possible.

In a successful design of a mosque, an acoustician must be in place at an early design stage and work closely together with the architect. This way costs will be reduced and the speech intelligibility will be secured to a high level.

The design of the sound system is equally important so it is of value if the acoustic consultant has a good knowledge of sound system design.

## Sound system

The sound system should follow the following simple but important rules:

- a. Loudspeakers are usually unattractive, so they should be heard but not seen.
- b. Selection of correct type, placement and number of loudspeakers for the purpose.
- c. Selection of the right type of microphones and other signal sources for the purpose.
- d. A simple and effective digital control system well programmed to make the use of the system as easy as possible.

Due to the often difficult acoustic environments in a mosque, it is important to use loudspeakers with well-defined dispersion characteristics as well as all other technical specifications suitable for the purpose. These data will give the designer the tools to avoid problematic reflexions and dispersions in the building. The audience with their clothes are usually the best absorbers available in the mosque.

This also means, the more visitors the better the sound.

By using the correct number of loudspeakers, mounted at the right places, even an acoustically poor mosque can get results much better than expected.

As some new loudspeakers have modern DSP technology included, it is possible to change directions of sound, levels and equalizations etc. depending on how many visitors there are, and where they are located are in the mosque.

The microphones are equally important, and have to be carefully selected for their purpose. Once correctly selected, the correct tone balance for the user has to be done.

All human voices are different, so they should be treated individually. By using modern DSP technology, this procedure is easy to do and all settings can be stored in a digital memory to make the selection simple for the user.

The digital control system, with proper programming, can sort out these things in a proper way. The user should only press one button for “his” voice and then select “his” correct sound level.

The beauty with a correctly programmed control system is that the user will have a simple system to use with minimum of buttons and switches to worry about, and only have to focus on his message.

More things to consider

A sound system needs electric power to work. Digital technology needs stable and reliable electricity. Therefore it can be essential to use an UPS (Uninterrupted Power Supply) for at least the most critical parts of the installation. With an UPS in the system disturbing clicks and pops from the system are avoided

Electronics tend to break down sooner or later; therefore redundancy is important as well as good quality equipment, easily available from well-known suppliers.

All digital wiring should have a redundant analogue system as an extra function security.

Make sure that local technicians are available which are familiar to the system.

Give the user a short instruction in what to do and not to do in front of a microphone.

It is clear to us that new and modern digital technology can be hard to use and not very cost effective in small mosques with limited resources. But with proper advices even a small mosque can get a very good sound system from simple analogue equipment.

Ensure to use a good sound consultant, able to select the right equipment and look at the acoustic possibilities, is always a good investment.

The author: The article is written by Jan Setterberg. M.Sc. Mechanical Engineering at Chalmers University of Technology, and with over 30 years of practical and theoretical experience in acoustics and electro acoustics. Jan Setterberg has performed over 250 different sound projects in Scandinavia, Europe and the Middle East. Jan is today Senior Advisor at Soliflex Svenska AB – [www.soliflex.se](http://www.soliflex.se). and associated to ADL Konsult consulting group – [www.adl-konsult.se](http://www.adl-konsult.se)